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MONOPOLY AND PROGRESS.

Dr. Franz Erich Junge-Hermsdorf.

THE FOUNDATION OF PRIVATE MONOPOLY POWER IN THE UNITED STATES.

Dr. Junge, by natural qualification and special opportunity and study, is remarkably fitted to discuss the peculiar economic conditions now disturbing industrial progress and prosperity in the United States. His article in this issue is the first of a group of three, the scope and interest of the following portions being admirably outlined in his concluding paragraph.—THE EDITORS.

IF we trace to its source the change of political attitude in the United States from the time of the formation of the Republic down to the beginning of this century, we find the general tendency of the situation well characterized by the following words of Woodrow Wilson: "The most striking fact about the actual organization of modern society is that the most conspicuous, the most readily wielded, and the most formidable power is not the power of government, but the power of capital." If we compare what the founders of the Commonwealth once intended. through the establishment of a democratic *régime*, to attain for the American people (partaking, as it were, in addition to the natural beneficence of a vast country, the benign influence of good laws under a free government) with the distribution of wealth, of power, of opportunity, and even of rights, as it obtains today, under the same *régime*—then it is evident that there must have been some error in the interpretation if the Constitution committed, or some flaw in its articles utilized by the succeeding generations, which has enabled a small but artful minority of the Commonwealth to gain control.

This departure from recognized political principles—equal opportunity and rights for all—was the natural outcome of the observance,

in the States, of the French doctrine, "*laissez faire . . . pas trop gouverner*," a precept of political economy advanced by the school of extreme individualism, which was so strong in the latter part of the eighteenth century that even in America it led, ultimately, to the enthroning of commerce over government. As a further result, and one of grave consequence for the Commonwealth, it led to the gradual absorption of public property by private enterprise, a large part of the rich natural resources of the land being turned over to wealthy individuals and combinations of rich men. There was at that time a prevalent belief in America—and in some quarters it is still active today—that the vast area of vacant country in the west and south would never be of any value to the Nation, unless it was exploited and utilized for the benefit of all. So what the country needed in those days, and what it obtained, was the rash work of pioneers, and American enterprise has had an affinity for it ever since.

Pausing, for a moment, to compare potentiality and productivity, or rate of utilization, as it obtains in the States with what obtains abroad, we note, at once, the primitive cause, underlying that spirit of boundless energy coupled with the strong desire for immediate profit; we understand that lack of forethought and want of durability, that tearing down and rebuilding on a new scale, which is as peculiar to American enterprise as it is astounding to the foreign observer. Because, in the old countries of Europe, by the weight of ages and by the sheer force of necessity, by the scarcity of resources and by the pressure of want, youthful enthusiasm has slowly but surely settled back into the channels of carefully devised plans and diligently directed effort, spasmodic and disconnected impulses have given way to a scientific national administration of the factors of production; extreme individualism has been replaced by an organic system of political economy, which is dedicated to the attainment of permanence of success rather than of immediacy, of quality of output rather than of tonnage, of preservation of the whole rather than of benefit to the few.

But in the United States, with its boundless resources, there was in those early days no apparent necessity for the Government to apply the rules of sound business to the affairs of the community at large, and so rights and resources and untold treasures were then given away with a lavish hand. We need only think of the vast stretches of land turned over to the railroads, and of the changing attitude of the latter—from pioneers to dictators—in order to realize that the granting of land privileges, not to speak of the right of the taxing power for private gain, and the evolution of technical prog-

ress—helpful though they were in building up the country and its industries—have led to the construction of that perilous machine which, in the course of time, has become the ruling power in the American Commonwealth.

"The belief is common in America," says Charles Francis Adams, "that the day is at hand when corporations far greater than ever—swaying such power as has never in the world's history been trusted in the hands of mere private citizens, controlled by single men—or by combinations of men—after having created a system of quiet but irrepressible corruption, will ultimately succeed in directing government itself." (Chapters on Erie, 1871.)

Since that time we have had ample opportunity to observe how the power of capital, by directing the activities of government in city, State and Nation, is at work undermining the country's economic foundations. As a matter of fact, there never was in the history of the world, as far as we know it, a better opportunity open for capital to exploit and exhaust at a rapid rate the irreplaceable treasures of the earth, than is rendered today by modern machinery; and, surely, in no age was technical talent utilized to so large an extent for strengthening the bulwark of plutocracy as it is in our age.

In order to lay bare the foundations of private monopoly power in America it will be necessary to dwell shortly on the constitutional principles which were devised with a view to reserve to the American people the possession of and rights to the public lands, including resources; and in connection therewith, to discuss briefly the various measures which were enacted in later years with a view of playing these public lands into the hands of private corporations. Article IV, Section III of the Constitution, treating of the power of Congress over public lands, contains the following clause:

"The Congress shall have power to dispose of and make all needful rules and regulations respecting the territory or other property belonging to the United States, and nothing in this constitution shall be so construed as to prejudice any claims of the United States or of any particular State.

While, in accordance with this clause, land was sold in the early days of the Republic to the highest bidder, this policy was changed later, by the enactment of the "Preemption Law," by which the nominal price was fixed at $1.25 per acre, no permanent settlement or residence of the purchaser on the land being required. The following "Homestead Law" enabled a man to take up 160 acres of public land and, by residing upon and improving it for five years, to acquire title without other cost than a small fee. The object of this law was, of course, to facilitate settlement and create homes, and in its original

form it probably had that effect. But the "Commutation Clause" of the Homestead Law, which was enacted a few years later, defeated its very purpose and brought special privilege to wealthy corporations, providing that after a residence upon a homestead claim of fourteen months the entryman may, by the payment of $1.25 an acre, secure immediate title to his land. Says G. E. Mitchell:—

> Under this law hundreds of thousands of acres of the best of the Government's lands of the West have been entered with but a mere semblance of improvement and settlement, commuted to cash, and transferred to speculators and syndicates, the entryman receiving a small bonus for the exercise of his right.

Thus through a modification of the original law, enacted under the disguise of promoting settlement, the public lands with all their inherent resources were largely brought into the hands of mortgage and loan companies, who are holding title to them now. But this was only the first step of capital in the direction of defrauding Government and disowning the following generations of their birthright.

A second move was instigated by the enactment of the "Desert Land Law." Its official purpose was to encourage the settlement of desert lands by enabling a man to enter 640 acres of such land, and upon irrigating a portion of it and paying $1.25 an acre, to secure title thereto. Its real purpose was, apparently, to assist speculators and other large holders to get control of land and water on the public domain by indefensible means. Quoting the above-named authority:

> This law has likewise been flagrantly abused and vast areas of rich lands, many of them absolutely non-desert, have been entered, patent secured from the Government and immediately transferred by the entryman to some live-stock syndicate or speculative corporation. In several of the grazing States tracts can be seen to-day of 10,000 or 20,000 acres, or even greater areas of contiguous land, acquired from the Government under the desert land law, but which have never been settled upon, and never been irrigated.

Yet this law is still in force, except that its unit has been reduced to 320 acres. (The much quoted "Carey Land Law" enacted in 1894 does not provide for any dealing by individuals with the United States Government. It provides only for transactions between the general Government and State Governments. In order to aid in the reclamation of desert lands and their sale in small tracts to actual settlers, such lands may be patented by the desert-land States, not exceeding 1,000,000 acres to each State, on condition that the State cause them to be irrigated, reclaimed, and operated, and that not less than 20 acres of each 160-acre tract sold be thoroughly cultivated within ten years.)

Another act serving to strengthen plutocratic interests was passed by Congress under the name of "Timber and Stone Law." It was

supposed to be for the benefit of the individual home seeker or settler, in that it allowed him to buy from the Government, for his own use, 160 acres of timber land at $2.50 an acre:

> This law has probably been even more flagrantly abused than any of the public-land-acquiring laws. Under it entire train loads of people—Eastern school teachers—have been transported by lumber syndicates into the finest timber regions of the West, and furnished the money to buy, each his 160 acres, and then immediately transfer it to the syndicate.

Vast tracts of land worth, according to Government agents, $100 an acre, have thus been sold by the Government for $2.50 an acre.

Mention must finally be made of the "Coal Land Law," which, though officially limiting individual entry to 160 acres, has, by fraudulent interpretation and the manipulation of dummy entrymen, enabled private interests to acquire holdings of lignite and coal lands, under other than their rightful classification, aggregating something like 30,000,000 acres. No constitutional provisions having been made by the founders of the Republic with the view of reserving to the Government title to the more important minerals of the land, all latent values hidden in the ground, which at any time in the future may be made available by the progress of technical science, are thus forever placed in the hands of private interests and therefore in the grip of monopoly. For where concentration is possible, competition becomes impossible.

Of course, in former years the disastrous effects of the above-named laws were hardly felt. But since the country is populated and consumers are in need of raw materials and of the products thereof, and since markets have sprung up and demands have been created, the supply of these commodities is controlled and restricted by private monopoly powers, and no alternative to unsatisfactory dealing is left available. As conditions appear at present, the American people are forced to pay a premium to enterprising corporations which were far-seeing enough to establish monopolies on practically all the necessities of life, and now derive special profits from those same lands which were once the common property of all. It seems unfortunate to the impartial observer of American conditions that the people have not been able so far, through the suggestion of their Chief Executive, to move Congress to repeal or, at least, to amend those laws, which have been admittedly so detrimental to the first principle of democracy—equal opportunity and right for all.

Though there is still a seemingly enormous stretch of land—amounting to about 700,000,000 acres—titled as property of the United States, it is seen upon careful investigation that a very large

part of that area is desert land, having practically no value whatsoever, being unfit for farming as well as for industrial pursuits. As regards the mineral lands, by far the largest percentage has undoubtedly passed into the hands of private corporations, their holdings of coal lands aggregating probably not less than 30,000,000 acres, while of the available water power 33 per cent (and not the worst situated) is already controlled by private interests.

It is only by studying the potentiality of output of the land that we can gain an approximate idea of the extent to which monopoly owns and is exhausting the soil of the United States. Leaving aside farm products and confining ourselves to minerals and metals only, we find that in the production of most of these materials the United States excels all other countries in quantity of output, producing in 1907: 428.8 million tons of coal, 166.0 million barrels of petroleum, 25.7 million tons of pig iron, 23.3 million tons of steel, 868.9 million pounds of copper, etc. Coal, iron, and petroleum being the three principal factors of the mineral production—those most easily lifted, those saleable on all markets without further improvement, and those most urgently needed in industrial pursuits—it is obvious that private monopoly should have endeavored to possess itself of these resources in due time. Hence we have coal, steel, and oil trusts.

But it is equally obvious that Government, being the trust of the people, and having to fulfil those high functions of restraint and service which private initiative cannot or will not perform, must in time awaken to the realization of the fact that these minerals and fuels are irreplaceable public necessities, carrying hidden priceless treasures of tangible value, which even a rich country like the United States cannot forever afford to throw away. Even if we have outgrown today the old physiocratic belief that the soil is *la seule source de richesse*, we know that he who controls the land and its resources controls also the people inhabiting it. Political prudence, therefore, suggests that control of this fundamental factor of production sooner or later be placed in the hands of the community as a whole.

Of course, there are some earnest and patriotic men in the United States who maintain that national ownership or supervision of the production of public utilities would be inferior, even, all points considered, to exploitation by private enterprise. Private ownership, they say, beside having the beneficial effect of building up the country and its industries, is superior in economic as well as in productive efficiency. Being more progressive and financially more successful than the other expedient, private enterprise brings more revenue to the Government and is able also to pay a higher rate of compensation to

labor. Moreover—this is the political argument—owing to the fact that nationalization of public utilities will create a large number of employees and officials, it is objected that such a class would be more or less dependent on political favoritism, being a willing tool for either the one or the other party that might be in power. Finally, it is argued that the rule of monopoly means in the United States the absence of any other adequate rule. The power of Federal and State governments having been weakened, at the foundation of the Republic, by an artificial system of checks and limitations, the Administration today possesses neither the austerity nor the competency to be entrusted with the exploitation of the country's resources. The result of State or national Government ownership and management, they say, beside increasing cost of production, would be to enable the unintelligent, by a majority vote, to enforce an instant lowering of the price of these commodities. But this temporary advantage, great as it may seem, would soon result in wasteful consumption and be followed later by exhaustion and famine prices. Private monopoly, according to the idea of these men, is therefore a natural corrective of the absence of paternal government. It is a result and a cause at the same time. If, then, monopoly gets its grip on one of the great natural resources of the land and charges twice as much for a commodity as it would cost under a competitive *régime*, the trust is, after all, the good angel saving the people from themselves, and protecting the country from that feverish inclination for waste and destruction which seems an unavoidable adjunct to "unlimited opportunities."

> If our ability to exhaust and destroy were commensurate with our proclivities, the United States would before now have become an emptied shell. (Harrington Emerson.)

Summing up, I have given in the above a short *résumé* of the history of public lands and resources in the United States and of their transference, through the power of capital, to private hands, together with a fair presentation of the arguments which are advanced by the moneyed interests in favor of private ownership and exploitation. In the following I shall attempt to show what influence the uneven distribution of the two principal production factors, nature and capital, and the overruling power of the latter, have on the third factor of labor; what influence emancipation and concentration of capital has especially on technical talent and productivity, which is the root of all progress. And, after having proven that such influence is harmful to national efficiency, I will show in detail what measures the executive circles of other countries (laboring, of course, under somewhat different conditions) have devised for preventing as far as possible the evils of private monopoly.

THE TWELVE PRINCIPLES OF EFFICIENCY.

By Harrington T. Emerson.

VIII. THE SIXTH PRINCIPLE: RELIABLE, IMMEDIATE, ADEQUATE, AND PERMANENT RECORDS.

Since our last issue went to press, efficiency engineering has become a national issue in the United States. Its immediate importance in connection with pending questions of railroad finance and economics is further emphasized in Mr. Emerson's article this month. This chapter—both by current associations and intrinsic quality—will be found one of the most engrossing of the series.—THE EDITORS.

WHEN a child touches the red-hot end of a poker, the information, advice, notice, record is reliable and lasting, also immediate and adequate. The scar is a perennial reminder of the mistake. Many of Nature's warnings are reliable, immediate, and permanent; they reach us and other animals through the senses—we hear, we see, we smell, we taste, we feel. Very few people allow themselves to be burned, because the penalty is reliable, immediate, and adequate; but they are not as shy about more deadly disease germs (probably a thousand people die of tuberculosis for one who is burned to death) because the result is not reliable nor immediate.

The object of records is to increase the scope and number of warnings, to give us more information than is usually received immediately through our senses. A steam boiler with water in it, a fire under it, and all outlets closed, is more dangerous than a hot poker. There is very little to indicate the imminence of disaster. It is too hot to touch with the hand, although it is conceivable that a spot in it might be so insulated as to permit the engineer to tell by feeling whether it was becoming too warm. A thermometer would give a better record; but usually there are three recording instruments, each reliable and immediate, one of them in addition adequate. The engineer watches his pressure gauge, he watches his water level glass, and the safety valve will pop even if he has fallen asleep. It is because of these three devices, one of which is independent of the man, that there are so few boiler explosions. All around us are many natural forms of advice, *of records*—the word is throughout used in its largest sense.

The object of records is to annihilate time, to bring back the past, to look into the future, to annihilate space, to condense a whole

railroad system into a single line, to magnify the thousandth part of an inch to foot-rule measurement, to gauge the velocity of a distant star by the shifting of the lines in the spectroscope, to annihilate temperature by enabling us to read the millionth of degree or the 10,000-degree difference between moon and sun heat.

Animals make and use records, reach out to each other through time and space; and the naïve surprise of the doe when the stag appears does as much credit to her modesty as the trail of musk left in her footsteps along many miles and for many days does credit to her involuntary common sense. Man alone reaches out to man through millenniums; and the pictures carved in stone, the hieroglyphics pressed in brick or cut in granite, tell us more about the intimate lives and philosophies of the Egyptians, of the Hittites, than we know of our own immediate ancestors, the Germans or the Gauls—than we know of our immediate neighbors, the Indians. Pictures and writing were a great invention; the reducing of music to written form so it could be reproduced was even more marvelous, since through the eye we recreate for the ears, thus bridging the gap between the senses. The perpetuation of sound through ages in the phonograph disk, the perpetuation of movement on a long film, these are part of man's triumph through records. The phonograph disk is, next to the brain, the most marvelous if not the most useful record man possesses, since all the throbs, moans, triumphs, all the *nuances* of a hundred instruments and of a hundred voices, pulsations of the air, are recorded by the needle point in a microscopic line; and that line, that perfect record, gives us again the same air pulsations, the same great instrumental and vocal chorus.

The efficiency engineer places himself on the apex of a hyperboloid, and by concentric rings around and below him he makes himself all powerful, all safe. His hyperboloid is staff organization; the other hyperboloid is line organization; but in the staff there are the ring of idealists, the rings of judicious plans, of competent advisers, of disciplinarians, of fair dealers, of records, of minute knowledge, of execution, of perfected conditions, of perfected operations, of stimulated co-operation.

Records are anything that give information. Men have always felt the need of records but they have not always known what they wanted nor how to secure them. In the great industrial plants one knows not whether to marvel most at the absence of reliable, immediate, and accurate records, or at the superabundance of permanent records, collected with painstaking and at great expense, but neither reliable, immediate, nor adequate. Even if the latter have all these

qualities, there is often great duplication, and as a consequence we find an immense amount of accumulation of very little value, which has cost far more than it need. An example of duplication may be found in the coal records for locomotives. Expenses of operating locomotives are generally recorded per mile, but suddenly a parallel set will crop up showing miles run per ton of coal. It has not been unusual in a great corporation's records to find a great variety of monthly tabulations, and when inquiry is made it is finally unravelled that twenty years before some president wanted a certain set of records, that his successor wanted a different set, which were started in parallel, that a third and fourth incumbent added their requests, but the old tabulations continue to be made and painstaking clerks work their monotonous lives away in neat compilation that no one has looked at, much less used, for a decade.

When the tramp piled and repiled the same cord of wood first on one side of the yard, then on the other, he was working efficiently but to no purpose; and having the soul of an artist he finally rebelled.

A clerical force may be hard at work, but it may accomplish very little and in the larger acceptance of the word it is inefficient, even as a hard-working steam engine using 50 pounds of steam per horse-power hour is inefficient in spite of its diligent consumption of coal.

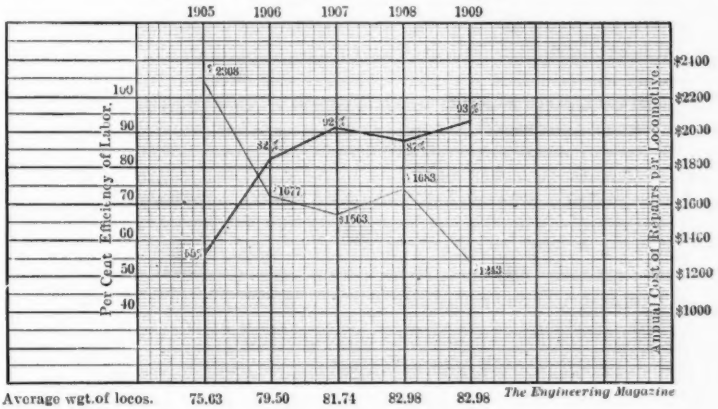
There are records of all kinds, many of them essential to our continued existence. There are in a much more limited way records of cost; and between the two extremes of universal records (as the swing of the earth in its seasons or the slow aging of every living and inanimate thing) on the one side, and cost records on the other, come records of efficiency, and these are what we particularly need in the present phase of industrial life. We have not yet learned to use to any great extent the conception of efficiency. We are interested in what eggs cost per dozen, not in the weight of each egg; we ask the price of coal per ton, but rarely know whether it contains 10,000 or 15,000 heat units per pound; we violently resist a demand for a 10 per cent increase in wages, but we tolerate a 50 per cent inefficiency in the worker. Not one in ten thousand knows even approximately the cost of food. Its price is known, but not its value, and if a curve of food values per pound should be drawn, and above each item its price, the line would look like the record of the seismograph during an earthquake, or the record of a magnetic needle during an eruption on the sun.

The whole United States was frantic in 1896 over the money question, and not one in a thousand of the gold advocates knew that owing to violent fluctuations in supply and use gold had varied in

value more than any other staple, not from hour to hour, as gold bonds and gold stocks fluctuate in value on the stock exchange, but from decade to decade. One of the tasks of modern scientific management, of efficiency and standard-practice engineering—two names for the same ideals—is to convert efficiency records into cost records, since the language of costs is understood by all, the language of efficiency only by the few. It is, of course, generally true that costs will decline as efficiency increases, but this is not always so.

A jeweller may work with the same efficiency setting on one day a $2,500 diamond in a gold stickpin and the next day setting a $0.25 bit of glass in a brass pin. Costs have varied, but not efficiency. A Japanese miner may work for $0.20 a day and an Alaskan miner for $15.00 a day. Each may work with equal efficiency, but the cost is very different. On the other hand, a farmer from the same field, planted to the same crop, plowed by the same man, team, and plow, raises increasing crops of the same grain; but wages, land values, and the price of horse feed might also increase so that decreased cost will not always directly flow from increased efficiency.

Efficiency of Labor and Cost of Locomotive Repairs.



Average wgt. of locos.	75.63	79.50	81.74	82.98	82.98
Mileage per loco. failure.	3160.	4900.	4250.	4611.	6200.
Tonnage hauled per loco. mi.	685.	725.	765.	770.	796.

RECORD OF EFFICIENCY AND COSTS IN LOCOMOTIVE REPAIRS.

In the refinement essential for the control of modern operations, it becomes increasingly necessary to state efficiencies even if we talk costs.

As a contribution to the solution of this problem a universal formula of cost and efficiency has been evolved which has the further

advantage of showing what records are really essential and necessary, what form they ought to take and what records are useless, confusing, and to be omitted. All the necessary reliable, immediate, adequate, and permanent records can be obtained and maintained for less expense than is usually incurred for misleading, delayed, inefficient, and ephemeral records.

The costs of modern operations consist of three elements. For instance, it may have cost in a recent year to operate all the railroads of the United States approximately:

For materials	$ 540,000,000
For personal services	1,035,000,000
For interest, depreciation, and other capital charges	1,000,000,000
	$2,575,000,000

Omitting millions, we can set up the formula:

Total cost	=	Materials	+	Personal service	+	Investment charges.
$2,575	=	$540	+	$1,035	+	$1,000
C (actual)	=	M (actual)	+	S (actual)	+	I (actual)

Let us assume that extended investigations would show very inefficient use of materials, very inefficient use of personal services and over-equipment, and that from a practical point of view it might be possible to state that the same general result could be accomplished with $370 of materials, $780 of personal service, and $600 of investment charges.* The formula of standard cost then becomes:

C (standard)	=	M (standard)	+	S (standard)	+	I (standard)
$1,750	=	$370	+	$780	+	$600

The efficiency of the whole operation is:

$$\frac{\text{C standard}}{\text{C actual}} = \frac{\$1{,}750}{\$2{,}575} = 68.9 \text{ per cent.} = \text{Total efficiency} = \text{E}$$

The relation of standard cost to actual cost gives the efficiency. This can be applied to each sub-part:—

$$\frac{\text{Material cost standard}}{\text{Material cost actual}} = \frac{\$370}{\$540} = 86.5 \text{ per cent.} = \text{Material Efficiency}$$

$$\frac{\text{Labor cost standard}}{\text{Labor cost actual}} = \frac{\$\ 780}{\$1{,}035} = 75.3 \text{ per cent.} = \text{Service Efficiency}$$

$$\frac{\text{Investment cost standard}}{\text{Investment cost actual}} = \frac{\$1{,}000}{\$\ 600} = 66.7 \text{ per cent.} = \text{Investment Efficiency}$$

* These figures are used only for illustration, not as the expression of a conviction. The author will shortly publish a monograph on the subject of railroad costs.

Actual costs can next be stated in terms of standard cost and of efficiency:—

$$\text{Total actual cost} = \frac{\text{Total standard cost}}{\text{Total efficiency}} = \frac{\$1,750}{68.5\%} = \$2,575$$

$$\text{Total actual cost} = \frac{\text{Standard cost of material}}{\text{Material effic.}} + \frac{\text{Standard cost of service}}{\text{Service effic.}} + \frac{\text{Standard cost of investment}}{\text{Investment effic.}}$$

$$\text{Total actual cost} = \frac{\$370}{68.5\%} + \frac{\$780}{75.3\%} + \frac{\$600}{66.7\%} = \$2,575$$

If we know in advance the standard or theoretical costs, if we know the current efficiencies, we can predetermine actual costs. What we all desire is to make the industrial machine as efficient as possible, to bring efficiencies up to 100 per cent, and when we do this actual costs will be the same as theoretical costs. We must first attack the problem theoretically. We must have standards and we must have efficiencies. When a pump or steam engine is tested, by every means we ascertain ideals; we then compare actualities with the ideals and we ascertain efficiencies. Similarly, in the great industrial problem we set up ideals, we measure against them actual performance, and we ascertain efficiencies, and as for pumps and for steam engines, so also do we use these efficiencies to prophesy future costs.

When actual and ideal performances are both recorded the relation in one month will generally serve to predetermine efficiencies in the next month; the relation of one year will generally serve to predeterimne efficiencies in the next year.

The elementary formula is, however, wholly inadequate for a real determination of efficiencies and has in fact led to most serious misconceptions and consequent mistakes.

Reference has already been made to the folly of the man who buys coal by the ton without knowing whether it contains 10,000 or 15,000 heat units per pound, who scrutinizes the cost of personal service without knowing its quality, who invests in new machinery without counting its hourly cost.

The cost of materials depends on two factors, the quantity and the price.

$$\text{Material costs} = \text{Quantity of units at price per unit.}$$
$$M_c = Q_m \; P_m$$

Very often a higher price will lessen the quantity, and it is evident that what is wanted is that Q P shall be a minimum cost.

In considering materials it becomes necessary to determine the efficiencies of both quantity and price.

$$\text{Materials actual} = \frac{Q_{st}\ P_{st}}{E_{mq}\ E_{mp}}$$

What is true of materials is equally true of personal service. Labor, like material, consists of both quantity and quality. The quantity of labor is measured by time, its quality by what it accomplishes. We do not measure the value of a musician by the number of notes he has struck—he may have been playing *largo;* but we do measure him by the time he plays and by the beauty of his performance.

The formula for personal service becomes

S = time in hours multiplied by wages per hour.
S = T W

As in materials, so in personal service, it is the proof of advancing civilization that the efficiency of T increases more rapidly than the efficiency of W. If it were not so there would be no inducement to advance W, there would be nothing over for the community. The locomotive engineer is paid higher wages than the Chinese coolie; the latter carries 150 pounds 20 miles in a day; the former hauls 6,000 tons 60 miles in a day; but the wages are not in proportion. Therefore piece work is necessarily wrong, since it gives a man all the gain due to his increased efficiency when he is only entitled to a large part, not to the whole.

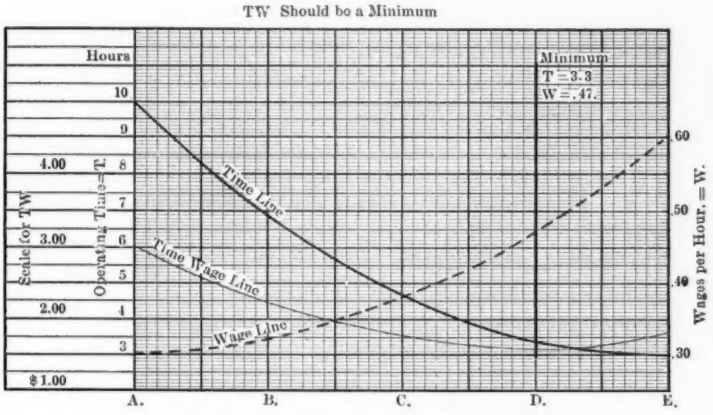
T cannot indefinitely decrease, neither can W indefinitely increase, and experimentally we must determine what combination of T W results in minimum cost.*

$$\text{Actual service cost} = \frac{T_{st}\ W_{st}}{E_t\ E_w}$$

Evidently an American at $0.50 an hour doing a given task in one hour is better than a Mexican taking four hours at $0.15 an hour. As T has so much more influence than W, it is of the first importance to make motion studies and time determinations as to every item of work, and, provisionally accepting current wages experimentally determined, to increase wages rationally as T falls off, even as locomotive engineers receive far more per hour than does the man with the hod or with the wheelbarrow.

What is true of materials and of personal service is equally true

* This relation at varying rates of time used and wages per hour is exhibited on the efficiency diagram opposite.



TW.	T.	W.	Total.
A	10.00	.30	$ 3.00
B	6.85	.32	$ 2.192
C	4.63	.38	$ 1.748
D	3.39	.47	$ 1.551 Minimum
E	3.00	.60	$ 1.80

The Engineering Magazine

EFFICIENCY DIAGRAM SHOWING RESULTS AT VARYING COMBINATIONS OF TIME USED AND WAGES PER HOUR.

of investment charges. Investment charges, like personal service, fall into *time* for any performance and the cost *per hour.*

$$I = T' R$$

in which T′ indicates time in hours and R cost per hour for capital charges.

If all the railroads of the United States are worth $14,000,000,000, it is evident that the annual capital charge for interest, depreciation, insurance and taxes might be $1,000,000,000—that the actual capital charge per hour is $114,155. If, therefore, as a token of respect to the memory of a dead president, all railroads should stop operations for 10 minutes at the time of his funeral, the cost would be about $20,000 in decreased efficiency of R, but the officials would hasten to make it up by increasing the output of the subsequent hours, thereby raising the efficiency of T′.

As for materials and for service, so also we must determine which T′ and R in combination result in the least cost.

In pay for services, the natural law is that an increase ought to decrease *time* in larger proportion, but in equipment it is very com-

mon to increase R unwisely and very greatly for a less decrease in T'. The same law prevails for equipment as for materials and labor. Additions to equipment should decrease, not increase, costs.

$$\text{Actual investment cost} = \frac{T'_{st}\ R_{st}}{E_{t'}\ E_r}$$

This relation of rate per hour to time is generally lost sight of. It is because it has been lost sight of that over-equipment is the rule in America.

Through materials, service and equipment we have worked up to the general cost formula.

$$\begin{aligned} \text{Total cost} &= \text{Materials} + \text{Service} + \text{Investment charges.} \\ \text{Total cost} &= Q\,P + T\,W + T'\,R \end{aligned}$$

Usually only the greatest of industrial managers realize that Q is more important than P; that T is more important than W, that R is more important than T', and that minimum total cost is realized when Q P is minimum, T W the minimum, and T' R the minimum.

For all the operations or for any single unit

$$\text{Total actual cost} = \frac{Q_{st}\ P_{st}}{E_q\ E_p} + \frac{T_{st}\ W_{st}}{E_t\ E_w} + \frac{T'_{st}\ R_{st}}{E_{t'}\ E_r}$$

This formula shows what records are wanted, namely, the six items of standard cost and the six items of corresponding efficiencies. No manager, no accountant, knows where he stands unless his records show him as to every operation:

The standard quantity of material
The efficiency of material use
The standard price of material unit
The efficiency of price
The standard quantity of time units required
The efficiency of time
The standard rate of wages for work of the character done
The efficiency of wage rate
The standard quantity of time for equipment
The efficiency of time use of equipment
The standard equipment rate per hour
The efficiency of equipment use

The formula is equally applicable to a totalized operation costing one mill as the page of a periodical, or to the operation of all the railroads of the United States as one great unit.

Records as to each detail, aggregated into records as to the whole, are one of the efficiency principles; records as to each item and every item today, records as to each and all items throughout a long period of time. He who has records of quantity and price—efficiencies of both, of every unit of material used, whether ton of rails or pint of oil; who has records as to time and wage rate for every operation, and the efficiencies; who has records as to time and investment charge per hour for every operation—he is in a position to apply the other practical principles and thus bring actual up to ideal. Records of this kind are simpler, cost less to keep up, than the usual industrial and cost records of great companies.

Cost accounting can be very simply and easily developed from the cost formula. The elaboration would carry us too far from the subject of records, reliable, immediate, adequate and permanent.

In a periodical publication as to each page there is material, personal service, equipment charge; and if the weekly edition runs to 2,000,000 copies of 80 pages each, a saving of the one one-hundred-thousandth part of a cent in cost per page means $800 in a year, enough to leave some profit after paying the salary of a man whose sole duty might be to prevent this minute waste.

When the formula is applied to railroad operating cost it inevitably shows that E is low. We have all seen locomotive safety valves popping and black smoke issuing from stacks. There is waste of fuel, but fuel is the largest single material item in railroad operation, amounting in fact to one-third of all material expense. We have all seen railroad day laborers dawdling over their work; but common labor, notoriously of poor efficiency, is the largest service item in railroad operation, being about one-eighth of the whole. We have all seen superfluous equipment, whole roads parallelled; and even if there were not an item of duplication, is it not conceivable that with a complete understanding of the problems by people, by government and by managers, railroads might secure money at 4 per cent instead of 6 per cent, thus reducing equipment interest charges $280,000,000* a year? By the test of the cost formula we can at least analyze every item of expense, determine standards and efficiencies, and strive for waste elimination. The cost formula is one of the instruments wherewith wastes can be detected and measured; but even as Kepler proved by measurement that all planets moved in elliptical orbits, so does the proper measurement of costs show where the savings, if made, must necessarily go.

* This item was not included in the recent estimate of a preventable railway operating loss of $1,000,000 a day.

The savage destroys, the barbarian squanders, but the civilized man conserves. Q P therefore measures civilization, T W measures civilization, T′ R measures civilization. There is scarcely a conceivable limit to quality, but quantity, natural resources, are limited; there is scarcely a conceivable limit to human skill; but each individual's span of time is inexorably limited. Friction and clumsiness, duplication and waste, can be eliminated from equipment; but each machine's life is limited. As to material, shall we use radium or shall we use sulphur; as to equipment, shall we use the old round blunderbuss bullet or shall we use the slim modern pointed bullet which travels twice as fast, goes four times as far, and weighs half as much; as to equipment, shall we use subways built with 4 per cent money advanced by the city, or shall we travel on slow surface cars drawn by horses and earning 10 per cent? As to equipment, shall we use the king's couriers on the king's highway or shall we use the telephone over a 1,000-mile gap? Shall the workers idle the long days through and be content with yams and a gee string?

Civilization is high when Q P is low; civilization is high in which T′ R is low; but reductions in Q P, reduction in T′ R must be balanced by increases in T W. Records, the instruments by which these relations are discovered and determined, are not dry and monotonous; they are an inspiration and a guide.

This is the final problem:—

Shall ultimately more of us work less time each, W remaining low, or shall we all work a reasonable time and greatly increase W? Having increased our command over materials, over equipment, what shall we do with the gain? I once heard an eloquent labor-union leader expound his creed: "Eight hours for work, eight hours for play; eight hours for sleep, and eight dollars a day." Eight hours for sleep—yes; eight hours for work—why not more or less as we find pleasure and delight or aversion and pain in it? A dollar an hour! Why not what we are entitled to through elimination of material and equipment wastes? Eight hours for play? There are moments in a man's existence that count more than monotonous months—the moment when Charles the Hammer learned that the Saracens were in rout; the moment when Columbus learned that land was lifting to westward; the moment when Lister conceived of asepsis, when Pasteur conceived the germ theory. Many of the minutes of the eight hours for play can be expanded into moments worth while, through the conquest of matter and of time.

> Gebraucht der Zeit, sie geht so schnell von hinnen.
> Doch Ordnung lehrt Euch Zeit gewinnen!
>
> —*Goethe.*

ILLUMINATION BY ALBA FLAMING ARC LAMPS, COLOGNE, GERMANY.

THE NEW ERA IN ELECTRICAL ILLUMINATION.

By Rollin W. Hutchinson, Jr.

II. FLAMING, LUMINOUS-ARC AND VAPOR LAMPS.

In the introduction to Mr. Hutchinson's first article, in our December issue, we called attention to the point that he has in view service to the *user* rather than the *manufacturer* of illumination. This is, of course, a service of far wider applicaion than the other, manufacturers generally being ably advised by specialists on their own staff, while not only individual users but the industry at large may profit from an impartial, well-informed review of comparative service characteristics and costs. Mr. Hutchinson's former paper discussed metal-filament lamps. It was expected to complete the review in this issue, but the magnitude of the work compels division into three parts, and the section on vapor lamps will be published in February.—THE EDITORS.

THE flaming or luminous-arc lamp is the invention principally of H. Bremer, who first placed a commercial "yellow arc lamp" on the market in 1899. Like nearly all important inventions, the flaming arc also had forerunners, and its history is a gradual evolution from the experiments of Casselman, in 1844, who suggested the employment of the salts of copper, strontium and zinc in the carbon electrodes of arc lamps to modify their color. His experiments were continued by French chemists, notably by Carré and Archereau in France.

The electrodes of flaming-arc lamps consist of carbons to which mineral substances are added, chiefly fluorides of alkaline minerals which cause the arc or vapor stream to be extended to considerable length and at the same time to become luminous, increasing thereby the luminosity of the light. In the ordinary enclosed carbon

STREET ILLUMINATION BY 4-AMPERE LUMINOUS ARC LAMPS, SOUTH MAIN ST., SALT LAKE CITY.
Courtesy of the General Electric Co.

arc 95 per cent of the light comes from the incandescent crater of the upper carbon, whereas in the flaming arc 25 to 35 per cent of the light emitted is due to the intensely luminous vapor stream. The salient feature of the Bremer lamp is the arrangement of the electrodes in an inclined position. In the class of superposed-electrode lamps using flaming carbons, so-called luminous arcs, are included magnitite lamps, Blondel lamps, and titanium-carbide lamps, together with carbon lamps using inclined electrodes but not impregnated with metallic salts.

In his experiments with the flaming arc Bremer discovered that the use of the electrodes in a vertical position in the lamp resulted in the formation of a kind of slag deposit on the tips caused by the mineral admixtures, which being non-conductive interfere with the uniform operation of the arc or unsteady it to an objectionable extent. Various means, such as, for instance, the use of water glass or boracic acid in the carbons, were tried to overcome the objectionable effects of the slag, but the only practicable method of overcoming the trouble consists in arranging the carbons in an inclined position with their active ends converging so that no slag will form in the path of the vapor. An additional advantage of the inclined position of the carbons is that nothing can obstruct the light of the arc, as is the case in the vertical-electrode arc.

Two further elements of much importance in flaming arcs are the "economizer" and the "blow magnet." The economizer of the original Bremer lamp consisted of a truncated metallic cone surrounding and supporting a porcelain disk through which the carbons are inserted. Its purpose is to increase the efficiency of the arc by concentrating the heat, and to lengthen the life of the carbons by limiting the air supply. The economizer also acts as a reflector owing to the white deposit of the arc flame settling on it, thus throwing most of the light in a downward plane.

The function of the blow-magnet is to prevent the arc from climbing up and damaging the economizer, particularly when the carbons are nearly burned out. When this occurs the arc is blown away by the magnet, or if necessary, extinguished. The blow-magnet can also be used to spread the shape of the arc as may be desired, preferably, however, into the form of a reversed umbrella. This feature of the blow-magnet makes it possible to increase the diameter of the carbons and thus lengthen the period between trimmings.

In most uses of the flaming arc, however, a blow-magnet is not required since the electric arc is itself a magnetic-field generator

and tends to force the arc away from the tips. Under some circumstances, as, for instance, with a 12-ampere flaming arc, it might become necessary to use the blow-magnet to produce a reverse action —that is, draw back the arc toward the carbon tips instead of forcing it away from them.

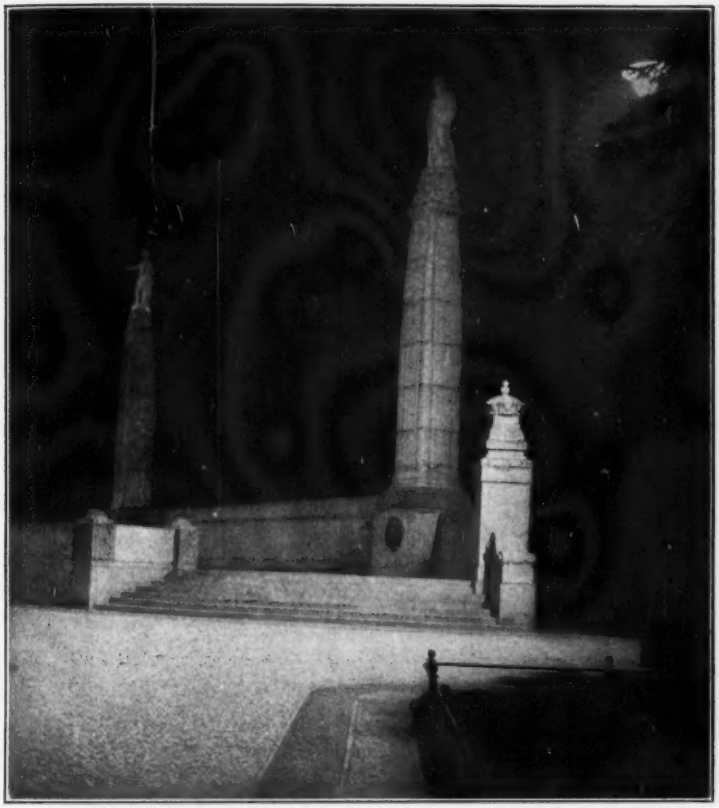
There are three kinds of flaming-arc carbons in commercial use, yellow, red, and pearl white. The yellow, which is the more extensively used, is produced by the admixture of calcium (lime) salts in the carbon in the form of a core. The red flaming arc, which in practice is more nearly a light pink, is produced by the use of strontium salts. The white color is produced by the use of barium salts. The most efficient of the three is the yellow carbon which is, as stated, the most popular. The illuminating power of the white-flame carbon exceeds but slightly that of the open arc with pure carbons, the red carbon having an intrinsic brilliancy slightly lower than the white.

EFFICIENCY AND ILLUMINATING CHARACTERISTICS OF FLAMING ARCS.

The intrinsic brilliancy of the flaming arc exceeds that of all other illuminants of the arc variety and its light efficiency is much greater than that of the tungsten lamp. The specific consumption of energy per mean spherical candle power is not over 0.5 watt per candle power ("mean spherical"), which figure exceeds that of the enclosed carbon arc from four to six times, and is also nearly three times less than that of the tungsten lamp.

This high illuminating power is thrown exactly below the center of the lamp, which enables it to be utilized more efficiently for some purposes than is the case with arc lamps having vertically superposed carbons, which emit their maximum light intensity at an angle of 45 degrees below the horizontal. This concentrated illumination feature of the flaming arc is not a desirable quality when such lamps are used for street lighting where the lamps are widely spaced, and it would be decidedly preferable if the light immediately under the lamp had a minimum intensity increasing with the angle from the vertical.

The reason for the high illuminating power below the lamp is that light is not emitted only from the luminous vapor path, but the major portion of the light comes from the incandescent carbon tips. The idea has been prevalent that all the light of the flaming arc is emitted by the luminous vapor, but this is incorrect, as Prof. Wedding has shown that only about one-quarter of the light comes



ILLUMINATION OF THE THIERGARTEN, BERLIN, BY ALBA FLAMING LAMPS.
Courtesy of the Charles L. Kiewert Co.

from the arc flame, the other three-quarters coming from the incandescent carbons. Since most flaming-arc lamps employ an ash receiver, the effect of a maximum light intensity in the downward plane is modified by the obstruction which the receiver offers.

Factors Influencing Economy of Flaming Arc Lamps.

Although as previously stated the intensity of light given by the flaming arc increases with the percentage of the salts added and the specific energy consumption is as low as 0.34 watt per mean spherical candle power with carbons containing 40 per cent of

ILLUMINATION OF THE FOUNDRY OF THE MISSOURI MALLEABLE IRON CO., EAST ST. LOUIS, MO., BY REGENERATIVE ARCS.
Eleven 110-volt direct-current regenerative arcs. Building 666 ft. long by 152 ft. wide.

"fluorspar" salts, nevertheless such a high proportion of metallic salts in the core is not practicable nor conducive to economy because of the excessive formation of slag. The economy of the flaming-arc lamp is also governed by the dimensions of the carbons. The diameter of the carbons is governed both by the kind of lamp and its construction, and is affected also by the kind of blow magnet and economizer used. The diameter must be limited, as has been pointed out, to obviate climbing of the arc. The economy of flaming arcs is hence limited by the length of the carbons, which of course limits their life. Increasing the length of the carbons increases their life and hence reduces the expense of trimming.

The candle power or size of the flaming-arc lamp also governs its economy to a certain extent. Tests have shown that it is more economical to use one large unit than to obtain the same candle power with a number of smaller ones, as the initial expense is greater, and the operating expense is decreased.

Summarizing the practical advantages and disadvantages of the flaming-arc lamp it may be stated that its first and foremost feature is a very high efficiency, exceeding greatly that of any other illuminant on the market. The chief disadvantages are the present high price of the carbons used on account of the high tariff imposed on their importation (nearly all the flaming-arc electrodes come from Germany), the frequent trimming required, the fumes given off, the deposit of ash inside the lamp, and its unsuitability for street lighting, except of a special kind.

Present-Day Field of Service of the Flaming-Arc Lamp.

In the United States the luminous or flaming arc has been in use only a few years and hence the number of applications which have been made of it are few as compared to its uses in Europe, particularly Germany, where the lamp originated and is widely employed, its extraordinary efficiency appealing greatly to the thrifty Germans.

In Germany the lamp is extensively used for municipal street lighting and fairly satisfactory results are obtained despite its unfavorable light emission for this purpose. The usual practice is to suspend the lamps from cables secured to the walls of houses on opposite sides of the street, the lamps being hung about 30 to 35 feet high in the center of the streets and spaced up to 300 feet apart.

The lighting of squares and plazas is done by mounting three or four lamps about 50 feet high on ornamental poles. In this way the

cost of installation is much reduced, as only one pole and one set of cables are needed.

In German practice it is also the rule to use carbons of different lengths depending on the season. Thus in winter when the nights are long the carbons are long, while in summer when the nights are short, their length is reduced. The strong feature of the lamp cutting itself out of service when the carbon is consumed permits it to regulate easily.

In Continental Europe luminous arcs of one type or another dominate the field of outdoor lighting since it has been the experience that the more light produced the more the public demands. For example, where two gas arcs were formerly used, four and occasionally six, flaming arcs are used; and it is no unusual sight to count as many as fifty to seventy-five flaming arcs on one block in Berlin.

The possibilities of increased illumination by the use of the flaming arc have been quickly foreseen by industrial establishments of all kinds both in the United States and abroad, and mills, foundries, machine shops, etc., report increased outputs and higher class of service as a result of its use. The immense volume of light which it produces permits the lamp to be suspended high enough to clear all machinery and yet illuminate the space below with powerful brilliancy.

The flaming arc is rapidly monopolizing the field of advertising by electric means. All kinds of amusement enterprises, parks and theatres realize the efficiency of the flaming arc for commanding attention, while the department stores of the large cities frequently utilize as many as fifty lamps of this type in front of their buildings.

Shopkeepers are increasing the brightness of their show-windows by employing flaming arcs and at the same time are decreasing the first cost of lighting as well as operating expenses. For this purpose the lamps are mounted above the window, the ceiling of which is of opalescent glass. In this manner a powerful volume of light is cast in the window, the source of light being concealed. It has been found that when so used the yield of light from a 550-watt flaming arc is equal to that of 2,000 watts in incandescent lamps.

In England the flaming arc has made but little progress but the outlook for its widespread adoption is most favorable. In London the high penetrability of the lamp has been found very serviceable during fogs. The utilization of the flaming arc in France has also been slow, the principal use of the lamp having been made in light-

ing a few streets in Paris and the larger cities. As is the case in most European countries the most satisfactory lamps in use are of German make.

Influence of the Flaming Arc in Compelling Use of Tungsten Lamps.

For interior illumination, particularly stores, the flaming arc has exercised a peculiar influence in making the use of the tungsten lamp almost compulsory. It is customary for shopkeepers who appreciate the value of the flaming arc as an advertising medium to install one or two of these lamps in front of their stores. The powerful brilliancy of the light causes the pupil of the eye to contract to such a degree that to the observer the illumination of the store appears defective, although in reality it may be excellent both in point of distribution of light and intensity of illumination. So great is the contrast that the storekeeper is obliged to use tungsten lamps in place of the ordinary incandescent lamps, and at the same time use more of them. In those cases where the flaming arc is used for advertising purposes, the shadows in the window are offset by studding the roofs with 60-watt tungsten lamps in mirror reflectors. The intensely brilliant light of both the flaming arc and the tungsten lamp

EFFECT OF ILLUMINATION BY TEN 110-VOLT ALTERNATING-CURRENT REGENERATIVE ARCS.

Building 60 by 90; lamps 10 ft. from sidewalk and 4 ft. from the building.

not only causes the light from the ordinary carbon-filament lamp to appear dim, but also shows up the sickly green light from the gas lamps and finally causes their displacement.

Maintenance Expense of Flaming Arcs.

The increasing use of the flaming arc for street lighting and for industrial-plant illumination makes the question of their maintenance cost as compared with ordinary arcs of great consideration. The energy consumption of the "differential" type of flaming arc is 550-watts, which at an average cost of 2 cents per kilowatt-hour makes the lamp consume $11 of energy per 1,000 hours for current. Taking the net cost of imported flaming-arc carbons, the cost per trim per 1,000 hours, labor included, is $8.50, making the total cost of trim and carbons $19.50 per 1,000 hours. The cost of repairs and globes per 1,000 hours may be estimated at $2, to which must be added interest on the investment, while a depreciation of $2 per 1,000 hours must also be included, which totals $23.50 per 1,000 hours of operation as the maintenance cost. Estimating the average yearly burning as about 4,000 hours the cost would be $94 per year per lamp.

The Magnetite Arc Lamp.

This type of lamp belongs to the luminous arc lamp group and is due chiefly to the investigations of Dr. C. P. Steinmetz, chief electrician of the General Electric Company. Its chief characteristics are long life of electrodes—approaching 200 hours on a single burning—light of great carrying capacity and good distribution, high intrinsic brilliancy with low energy consumption.

The arc derives its name from the fact that the negative electrode is composed chiefly of magnetic iron ore with a certain percentage of titanium oxide added (TiO_2). The positive electrode is of copper, the size of which has but little effect on the behavior of the arc.

The magnetite arc differs radically from the ordinary carbon arc and also from the flaming arc in that it can be operated only on direct-current circuits. It is also essential that the magnetite electrode should form the negative electrode which is, as a rule placed in the lower holder of the lamp. If magnetite is used for the positive as well as the negative electrode the arc falls off both in brilliancy and efficiency; and the positive electrode, which when metallic lasts 2,000 hours or more, is more rapidly consumed.

The bulk of the electrodes consist of magnetite, the particles of

OUTDOOR LIGHTING BY "ALBA" FLAMING ARC LAMPS.
The upper view is in the streets of Cologne; the lower, in the suburbs of Berlin.
Courtesy of the Charles L. Kiewert Co.

which make the arc stream a good conductor, while the titanium oxide is introduced to give luminescence and to neutralize the excessive blue rays emitted by the iron arc alone. The use of magnetic iron ore and titanium oxide alone in the negative electrode, however, would make the arc too unstable for any commercial use, hence to obviate this defect and at the same time increase the life of the elec-

trodes, either oxide of chromium ($Cr_2 O_3$) or chrome iron ore ($Fe_2 Cr_2 O_4$), termed chromite, is added, the latter, perhaps, being the most suitable. The slag formed by the magnetite is a good conductor when cold, so that difficulties in starting the arc are overcome. Ordinary magnetite contains too many impurities to be used, and contaminating substances, such as lime, silicia and magnesia, must be first eliminated.

The arc of the magnetite lamp appears to arise from the surface of the negative as a high velocity blast impinging on the copper positive, and since the greater portion of the light is emitted at the negative end of the vapor bridge, a reflector must be employed to give the most satisfactory results. It is thus obvious that considerable gain in efficiency is practicable by burning the arc reversed or with the negative in the upper holder of the lamp. Until recently the mechanical difficulties to this arrangement caused it to receive small consideration, although the advantages were everywhere recognized. In the Westinghouse magnetite arc the negative electrode is in the upper instead of the lower portion of the lamp.

The arc of the magnetite lamp is very long and gives a better distribution of light than does the old open-arc carbon lamp, while the energy consumption is only 4 amperes at from 65 to 75 volts. The maximum light is emitted between 20 degrees and the horizontal, while the total light produced by a 300-watt magnetite arc is approximately double that of an alternating-current series enclosed carbon lamp consuming 450 watts.

The principal disadvantages of the magnetite lamp may be briefly stated as follows and are due to the positive, in the main: (1) Continuous service of the lamp causes films to be deposited on the positive electrode, which deposits project downwards like icicles and greatly obstruct or sometimes entirely cut off the light; (2) the substances employed in the positive may oxidize from the intense heat of the arc and from oxides, which, when cold, are insulators; (3) particles of molten matter are absorbed by the positive from the negative and the burning of the arc is thereby hindered.

Experience has shown that unless special means are provided for the ventilation of nearly all types of luminous or flaming arc lamps the solid matter emitted by the arcs in the form of smoke is deposited upon the inclosing globe forming a semi-opaque coating which is greatly detrimental to the light emission.

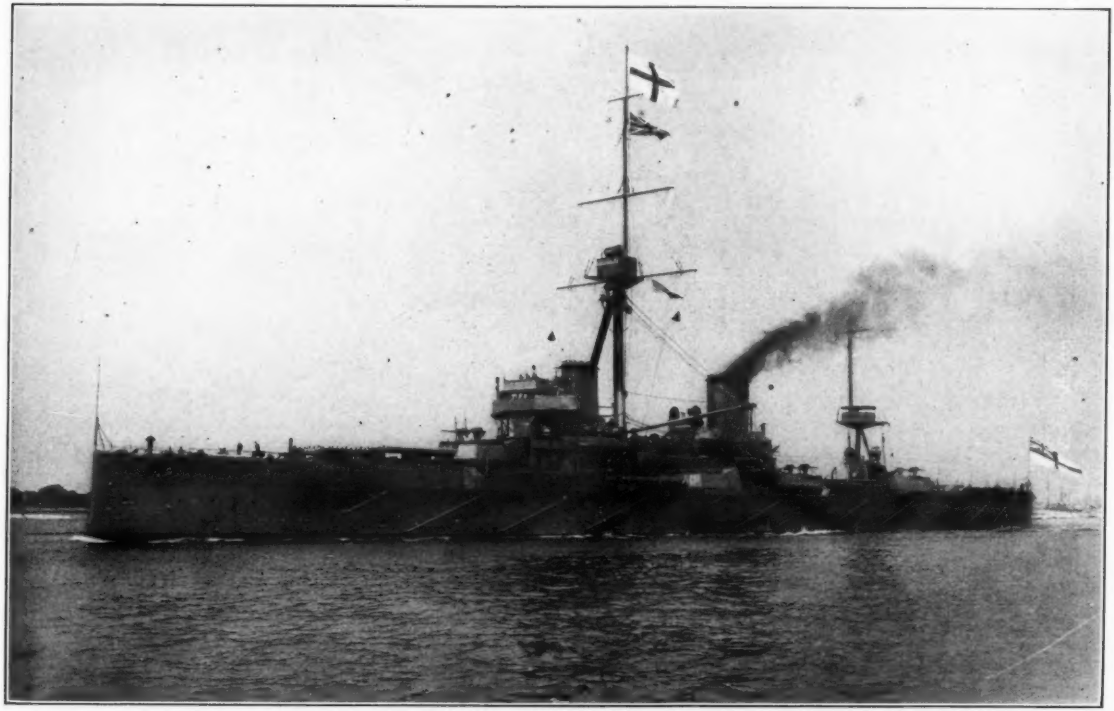
Illumination and Color.

The spectrum of the magnetite arc with electrodes of correct composition approaches that of sunlight more nearly than that of any other kind of arc lamp, while the distribution of the light rays in a plane about 10 degrees below the horizontal makes the lamp especially suitable for street illumination.

The unusual advantages of the magnetite arc, such as long life of electrodes, high luminous efficiency with low maintenance expense, are resulting in the displacement of the enclosed arc lamp for new installations and there are many indications that the magnetite arc will supplant the older types of arcs for street lighting, entirely.

Magnetite lamps operate most satisfactorily on direct-current circuits, as has been pointed out, the lamps being connected in series and receiving energy either from a constant-current arc dynamo or from an alternating-current circuit, the current being transformed into direct current by means of "mercury rectifiers." The alternating current to be rectified is first sent through a repulsion-coil regulating transformer (or constant-current transformer) and then goes through the rectifier to the lamps. The combined efficiency of the constant current transformer and mercury rectifier is over 90 per cent.

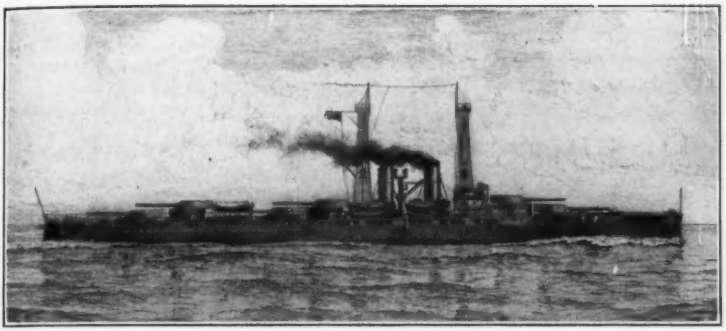
The chief objection to the luminous arcs as made at present is that the attempt to specialize the lamps in the direction of long life has resulted in its failure in other desirable qualities. It is very difficult to obtain authoritative values for these arcs for the reason that until very recently they were designed entirely for low input and have been generally tested with clear globes.



H. M. S. DREADNOUGHT.

Note:—The Dreadnought, Bellerophon and Collingwood classes are much overweight, drawing considerably more water than called for by the design, and displacing between 20,000 and 21,000 tons each. The figures in the tables on page 524 are *nominal*, only.

Photo by Stephen Cribb, Southsea.



THE U. S. BATTLESHIP ARKANSAS.

DREADNOUGHTS—WHAT ARE THEY?

By Sidney Graves Koon, M. M. E.

In view of the importance of the pending naval appropriations and of the increasing public interest in the efficiency of naval defence, this clear and thorough review of the most advanced battleship types and naval programmes is both timely and valuable.—THE EDITORS.

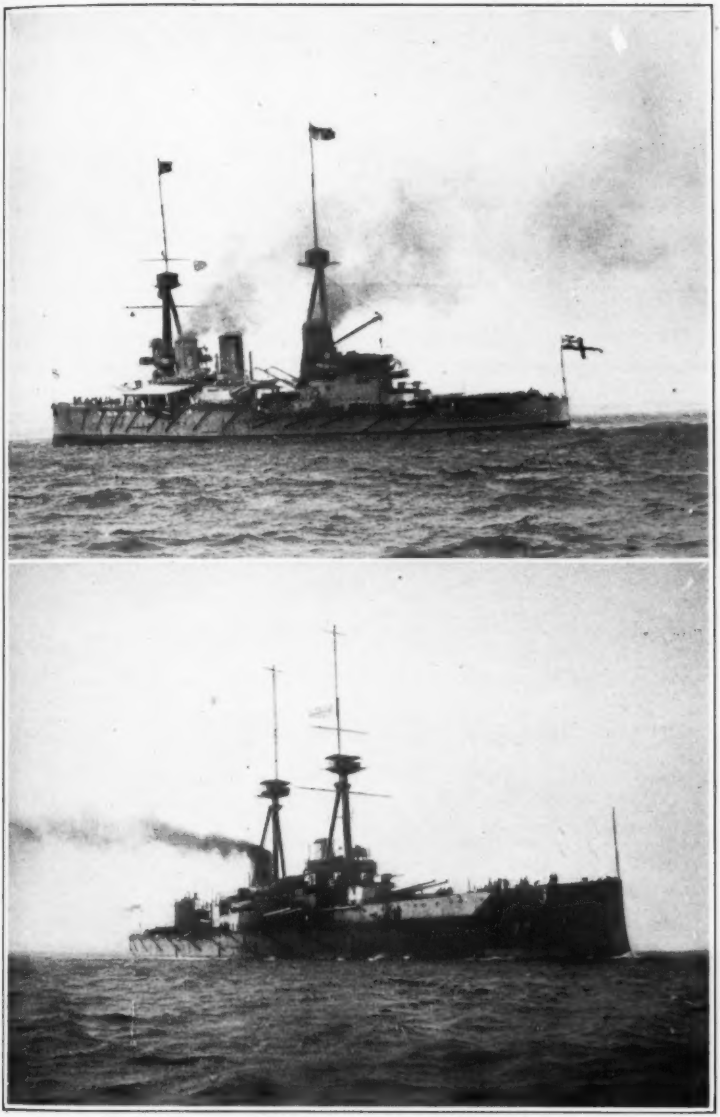
BATTLESHIP-DESTROYERS—the extreme of power, both ballistic (in the guns) and dynamic (in the propelling machinery)—the sudden culmination of years of steady and painstaking development, the last few stages being bridged by a half-dozen "semi-*Dreadnoughts*"—disturbers of the peace of mind of naval administrations, and hence—incentives to greater and ever greater budgets, until the price of peace grows in some quarters almost intolerable. This, and more, *Dreadnoughts* are. They have revolutionized naval design in many ways, increasing by thousands of yards the assumed practicable battle range; stimulating, to meet this condition, the development of the most powerful and wonderfully accurate torpedoes—tiny submarines which, without guidance once they have left the firing tube, can be relied upon to travel miles in a straight line, carrying a deadly charge of guncotton far into the enemy's ranks. New theories of gunnery, involving the use of but one size of gun, and that the largest, have resulted in eliminating all intermediate sized guns, and relegating the smaller pieces to the sole duty of guarding against the attacks of torpedo vessels. This makes for simplicity in fire control, or directing the operation of the battery

against the enemy or the target; for all the projectiles will have the same sort of trajectory—all will rise to the same height in their travel over equal distances, and the guns will all be given the same elevation.

New problems, and grave ones, have entered into the design:—the proper disposition of several heavy turrets, so that too great a concentration of weight in one spot is avoided, yet so that no one of them interferes in any way with any of the others, while all have the greatest possible arc of training; the provision of adequate locations for the stowage of boats—for the familiar hammock netting capped by boatskids is a thing of the past; the fitting of armor in such a way as to localize the effects of a hit from a heavy projectile filled with high explosives; the almost total elimination of wood in the construction, and even for furniture, because of the serious effects of a conflagration started by bursting shells; and, in the latest ships, a sort of embryo protection against aeroplanes by means of an armored upper deck. And, be it said, *Dreadnoughts* are *not* put up in small packages.

But, getting away from this generalization, we once more face our topical question—What are *Dreadnoughts?* Briefly, they are large battleships of high speed, carrying from eight to twelve or more very heavy guns, and having hull and guns extensively protected by heavy armor. Compared with the latest ships of the "pre-*Dreadnought*" epoch, such as the United States ship *Connecticut,* in which Evans made his famous cruise, the *Dreadnoughts* are larger by several thousand tons, faster by three knots or more, and have broadsides of from eight to twelve heavy guns as against four on the *Connecticut.* The numerous intermediate guns mounted on ships of the *Connecticut* and contemporaneous types have disappeared. The relative area of the side covered by armor has increased, while the maximum armor thickness has remained about the same.

The most vexing problem in connection with *Dreadnoughts* has been that of arranging a satisfactory distribution of the tremendous batteries carried. Of the three nations which first entered the field and undertook to solve this problem, the United States is the only one which seized at the start an idea which has persisted to the present, and which, greatly to the credit of the American designers, has now been adopted by the British Admiralty—that of mounting all the heavy guns in pairs in turrets, all on the center line. The original *Dreadnought* and her six immediate successors had two of the guns masked by the superstructure, and could train on one broadside only eight of the ten carried. This was avoided in the *Indomitable* by mounting two turrets *en echelon,* or diagonally, thus allowing for both a heavy bow and stern fire, and a complete broadside; but the strain



ABOVE, H. M. S. INDOMITABLE; BELOW, H. M. S. VANGUARD.
See page 524. Photo by Stephen Cribb, Southsea.

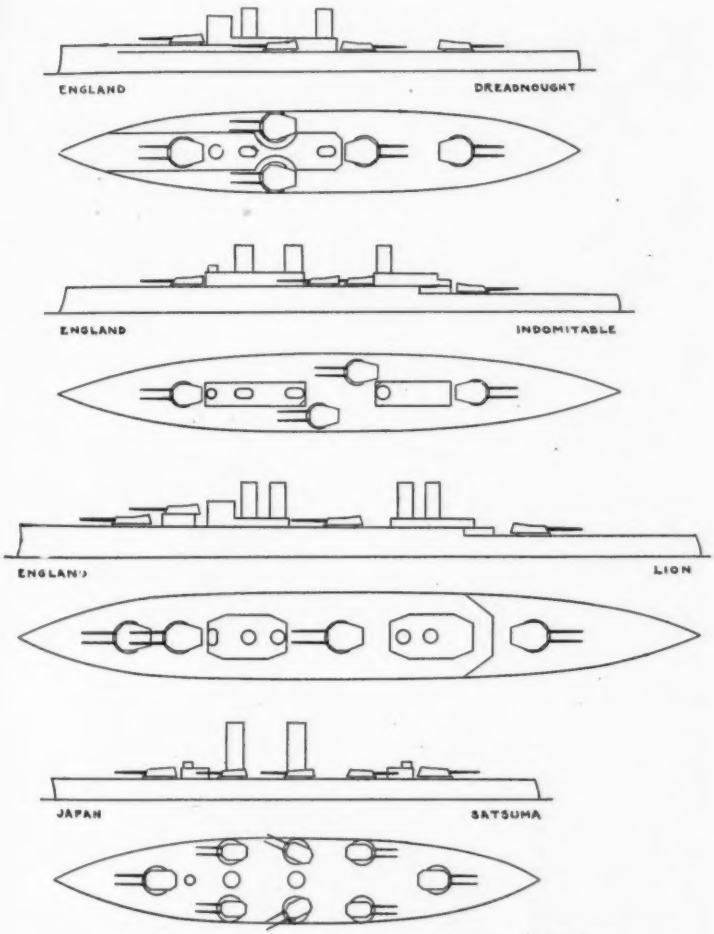
on the decks and the necessarily limited arc of cross-deck firing made the arrangement unsatisfactory. It has been followed, however, in a great many ships. The original German ideal was proclaimed to be "all guns on one broadside," and such was the number of guns which it was proposed to so mount that the greatest alarm pervaded British naval circles, lest the Teuton, by some magic arrangement of so many weapons, might have stolen a march on his cousins. When the ships actually took form, however, only eight guns were found available on either side, of the twelve carried, and everybody breathed more easily. But more of this anon.

The British Ships.

First chronologically and numerically, these ships should be first described. For purposes of reference, a list follows, showing the names and main particulars of all *Dreadnoughts* built or building for the British navy, and including the two "semi-*Dreadnoughts*" *Agamemnon* and *Lord Nelson*.

	Tons.	Speed.	Battery.	Broadside. lb.	Armor. in.	Length. ft.
Agamemnon *Lord Nelson*	16,500	18.8	4 12 -in. 10 9.2-in. 15 3-in.	5,388	12	425
Dreadnought	17,900	21.2	10 12 -in. 27 3 -in.	7,000	11	520
Bellerophon *Superb* *Temeraire*	18,600	21.5	10 12 -in. 20 4 -in.	7,203	11	520
St. Vincent *Collingwood* *Vanguard*	19,250	21.	10 12 -in. 20 4 -in.	7,203	11	530
Neptune *Hercules* *Colossus*	20,400	21.	10 12 -in. 20 4 -in.	8,965	11	540
Orion *Thunderer* *Monarch* *Conqueror*	23,500	21	10 13.5-in. 20 4 -in.	12,965	12	550
Indomitable *Invincible* *Inflexible*	17,250	28.	8 12 -in. 16 4 -in.	7,172	7	560
Indefatigable *Three more not yet named*	19,200	26.	8 12 -in. 20 4 -in.	7,234	8	578
Lion *Princess Royal*	26,350	28.	8 13.5-in. 20 4 -in.	10,434	8	680

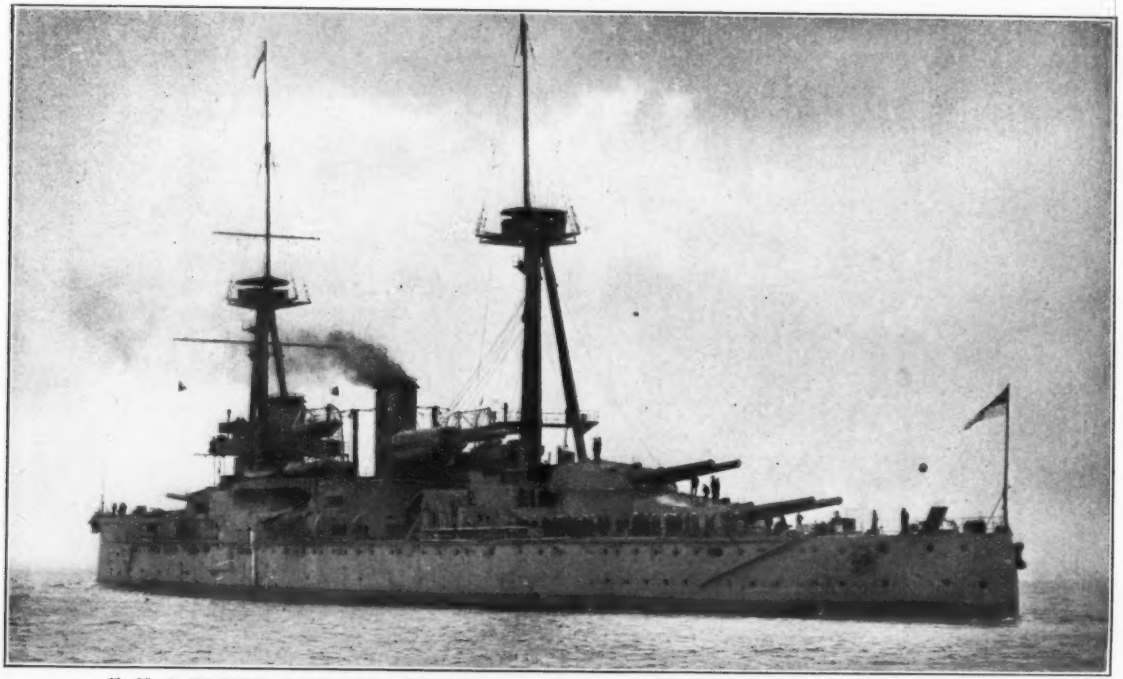
The diagram showing the battery arrangement of the *Dreadnought* is equally available for the *Bellerophon* and *St. Vincent* classes. In each case, there are three turrets on the center line, and one on either wing, a little forward of amidships. This gives a fire of six guns dead ahead or dead astern (but only four, when we get two degrees from the exact axial line) and eight on the broadside. Contemporaneous with these ships were the *Indomitables*, also illustrated, where the *echelon* arrangement of the central turrets, above referred to, gives the same number of guns ahead, astern, and on the direct broadside as with the *Dreadnought*. At a small angle away



THE BRITISH SHIPS. SCALE ABOUT 1 INCH = 165 FEET.

from the direct broadside, however, the "off" pair of guns is out of action, and six weapons are all that can be used. This *Indomitable* arrangement, slightly modified, to give less interference of the guns with one another, has been followed in the *Indefatigable* type of four ships, three of which are being built from moneys subscribed by as many of the crown colonies.

The first evidence of the influence of American design on the British ships is in the *Neptune* class, where the two after center-line



H. M. S. NEPTUNE, 20,000 TONS; THE FIRST SHIP IN THE ROYAL NAVY TO HAVE SUPERPOSED TURRETS.
Her beam barbettes, *en echelon*, give her a full broadside of 10-in. guns. Photo by Stephen Cribb, Southsea.

turrets are so mounted that the guns of the inner one may be fired over the after turret. This ship also used the *echelon* arrangement for the central pairs of guns. The illustration of the Argentine *Rivadavia* shows the manner in which these ten guns are mounted, if we remember that in the *Neptune,* one of the two forward turrets of the *Rivadavia* is missing. But it was in the *Orion* class of four ships, of which the vessel named was launched August 20, 1910, that the design came out so like the American *Delaware* (see page 528) as to cause comment. The main difference is that there are three turrets forward and two aft on the *Orion,* while the reverse is the case with the *Delaware.* Another point of difference is that on the *Orion* the middle one of the group of three turrets is the one which is raised above its fellows, while on the American ship the elevated turret is the one nearest the middle of the ship. In each case there can be used four guns ahead, four astern, and ten on either broadside.

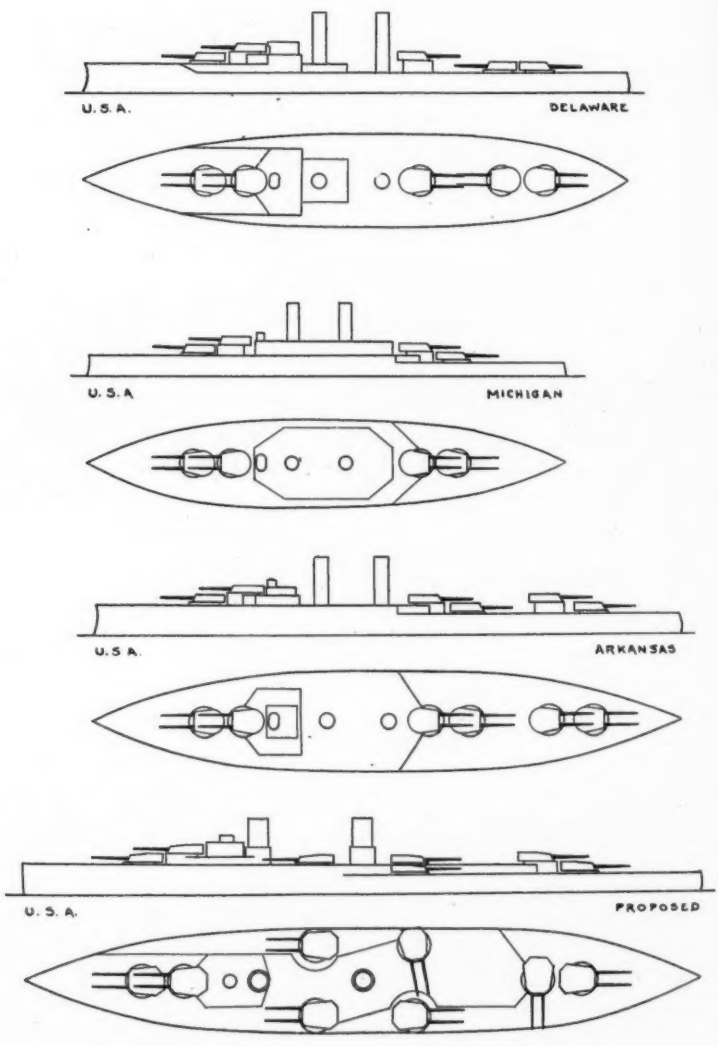
The latest of the British ships are the *Lion,* launched August 6, 1910, and her sister *Princess Royal,* still on the stocks. These are shown, by the diagram, to have their eight guns in four turrets on the center line, like the *Michigan,* also illustrated; but, unlike the latter ship, only two guns can be fired aft, though four can be trained ahead, and eight on either side. These two ships are remarkable from the fact that they are the first war vessels to approach 700 feet in length—the first, in fact, to exceed 600 feet! and also that, with their 70,000 horse power, furnished by steam turbines, they are the first to pass 50,000 horse power.* They have about the same power as the Cunard liners *Lusitania* and *Mauretania,* and, with hulls one-third lighter, are expected to exceed the high speed of those famous ships by about three knots. Needless to say, they represent an extremely expensive investment, not only in capital cost, but in maintenance and depreciation.

THE AMERICAN SHIPS.

	Tons.	Speed.	Battery.		Broadside. lb.	Armor. in.	Length. ft.
Michigan *South Carolina*	16,000	18.8	8 12-in.	22 3-in.	7,114	11	450
Delaware *North Dakota*	20,000	21.6	10 12-in.	14 5-in.	9,120	11	510
Florida *Utah*	21,825	21.	10 12-in.	16 5-in.	9,180	11	518
Arkansas *Wyoming*	26,000	20.5	12 12-in.	21 5-in.	11,040	11	554
Oklahoma *Nevada*	29,000	21.	10 14-in.	20 5-in.	14,600	11	570

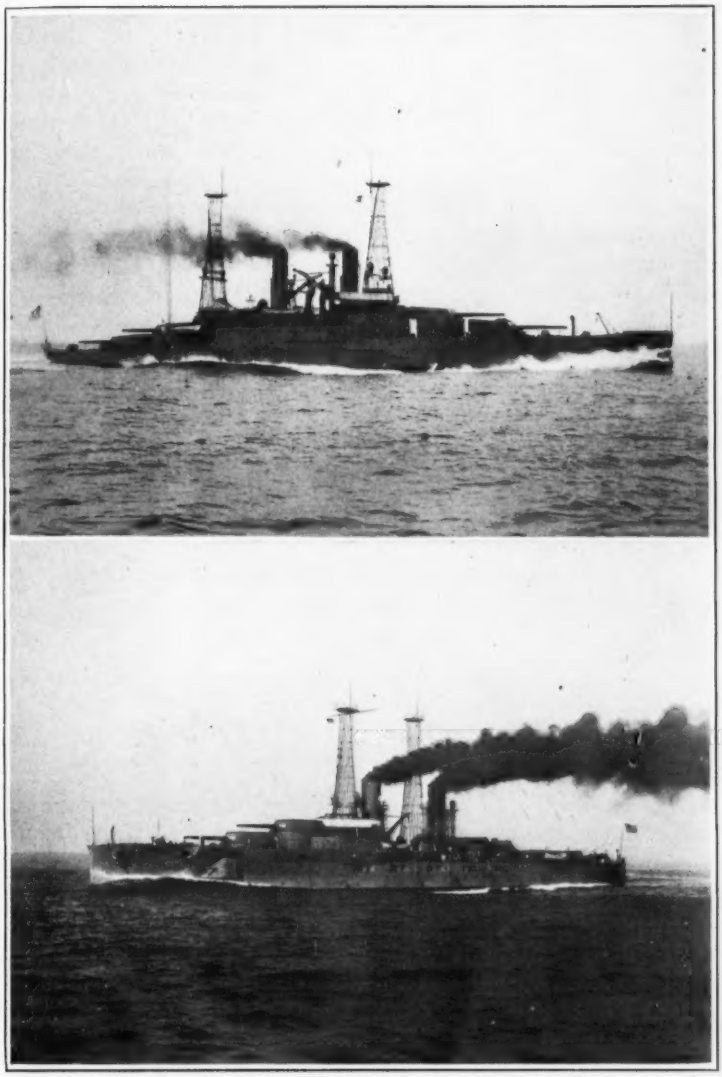
The *Michigan* type immediately followed the *Connecticut* class, of the same displacement. The former is illustrated, showing four tur-

* The *Von der Tann,* on trial, has also exceeded this figure.



THE AMERICAN SHIPS. SCALE ABOUT 1 INCH = 160 FEET.

rets on the center line, the inner ones being elevated for training over those at the ends, thus giving a fire of four guns ahead or astern and all eight on the broadside. This appears to be the most successful



ABOVE, U. S. S. MICHIGAN; BELOW, U. S. S. DELAWARE.

Copyright, 1909, by N. L. Stebbins. The *Michigan* is shown making 18.60 knots on her trials.

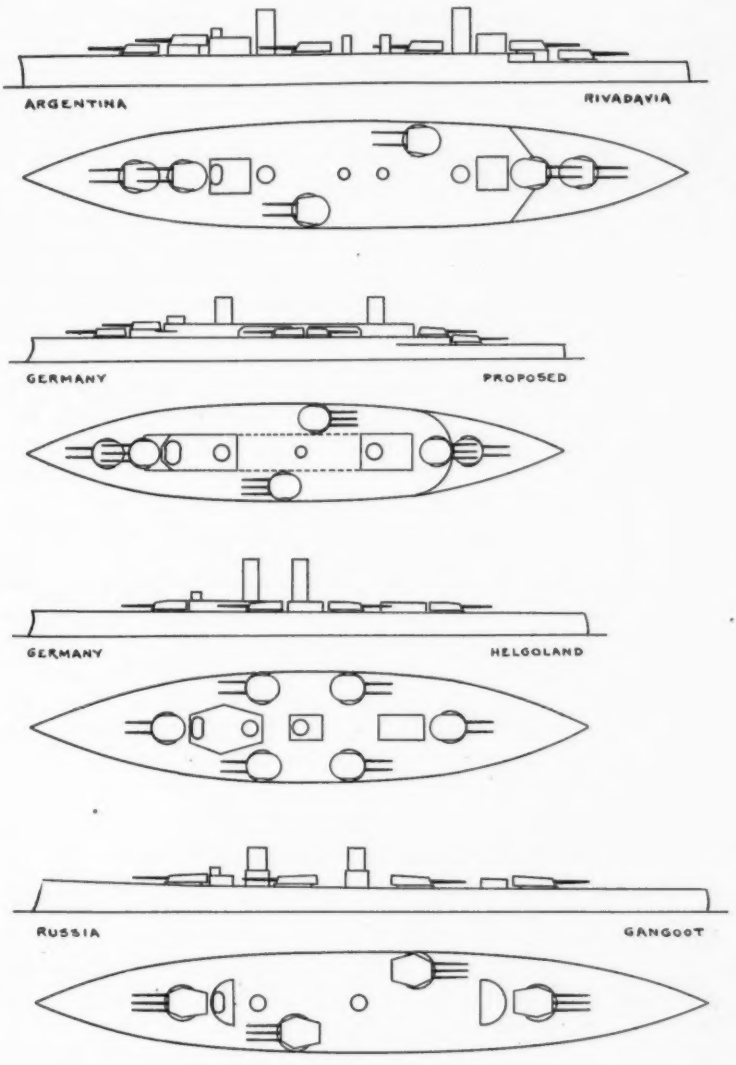
type yet developed, having now been adopted as such by England. It gives the best "all-around" fire possible; and many designers feel that the best general results would be obtained by following this arrangement of four turrets, increasing the caliber of the guns, if need be, or even mounting three guns in a turret, as with the Russian *Gangoot* class (see illustration). The increased power of some of the latest designs along other lines would then be met by a corresponding increase in the number of ships of this type, uniform in general design, and with all the tactical advantages conferred by a homogeneous fleet.

Following the *Michigan* came the *Delaware* and *Florida* classes, the latter being merely a development of the former. Each has ten heavy guns mounted in five turrets on the center line, and all available on either side. A further development, involving the addition of another turret on the center line, has resulted in the *Arkansas* and *Wyoming*, of 26,000 tons displacement, and carrying twelve 12-inch guns, arranged as shown on the diagram. The *Oklahoma* class follows the *Florida*, so far as gun disposition is concerned; but as the guns are increased from 12-inch (870-pound projectile) to 14-inch (1,400-pound projectile) the new ships are necessarily much larger.

THE GERMAN SHIPS.

	Tons.	Speed.	Battery.			Broadside. lb.	Armor. in.	Length. ft.
Nassau *Posen* *Rheinland* *Westfalen*	18,700	19.8	12 11 -in.	12 5.9-in.	16 3.4-in.	6,888	9.8	472
Helgoland *Ostfriesland* *Thüringen* *Six more not yet named*	21,000	20.5	12 12.2-in.	12 6.7-in.	16 3.4-in.	8,800	9.8	490
Von der Tann	18,700	25.	8 11 -in.	10 5.9-in.	16 3.4-in.	6,780	6	560
Moltke *H* *K*	19,500	28.	8 12.2-in.	12 5.9-in.	16 3.4-in.	8,656	6	560

The German fleet of *Dreadnoughts* is nothing but an "answer" to that of England. As soon as the particulars of the original *Dreadnought* became known, the *Nassau* was designed, and, after many vicissitudes, finally built. But she bears no resemblance, in steel, to her first drawings. As mentioned previously, nothing was to be considered which did not allow all guns to be trained on one broadside. So designs resembling the present actual ship, as well as modifications carrying fourteen guns (the extra turret, on the center line, being elevated so as to fire over one of the end turrets) and sixteen guns arranged as in the Japanese *Satsuma*, were discarded in favor of a hybrid arrangement of sixteen guns in six turrets, as shown in the diagram "proposed." This would have permitted the attainment of the stipulated ideal; but it must have been found totally impracticable



GERMANY, RUSSIA AND ARGENTINA. SCALE ABOUT 1 INCH = 150 FEET.

on account of the limited displacement allotted, and was finally abandoned in favor of a very inferior disposition, illustrated by the diagram of the *Helgoland,* which is merely an enlargement of the *Nas-*

sau, with heavier guns. Had the arrangement of turrets in the sixteen-gun ship "proposed" been retained, but with only two guns to each turret, it would have been identical with that which was later adopted for the two Argentine ships building in the United States, and the Brazilian *Rio de Janeiro,* building in England—a most successful design. In connection with the German answer to the *Indomitable,* a ludicrous case of misapprehension, based on an erroneous statement of the displacement of the English ships, is noted. Instead of 17,250 tons, the figure was given as 15,000 tons; and the Germans gravely went to work to design a ship of that displacement and 25-knots speed. She was actually so far advanced in construction when the hoax was discovered that she was carried to completion. This ship, now the *Bluecher,* was given originally an armament of eight 11-inch guns, to meet the British eight 12-inch pieces. These were to be mounted in pairs in four turrets arranged lozenge-wise—one on the centerline forward, and one aft, and one on either side, amidships. This battery was later increased to ten guns, as being better fitted to cope with the eight larger British weapons. The two extra guns were mounted singly in two turrets, one on each side, the resulting six turrets being arranged as in the present *Nassau.* But this was too much for her light displacement, and the battery, as finally fitted to the ship, consists of twelve 8.2-inch guns, in six turrets arranged as last noted. She is not a *Dreadnought,* in any sense of the term.

The present *Von der Tann,* as originally designed, was to have carried twelve 11-inch guns, disposed as in the present Argentine ships. This, again, proved too heavy, and the ship as completed has only eight, in four turrets, arranged as in the *Indomitable.* The *Moltke,* and later ships of this class, have the same arrangement, but carry heavier guns.

THE FRENCH SHIPS.

	Tons.	Speed.	Battery.			Broadside. lb.	Armor. in.	Length. ft.
Danton *Condorcet* *Diderot* *Mirabeau* *Vergniaud* *Voltaire*	18,320	19.5	4 12 in.	12 9.4-in.	16 3-in.	6,902	10.8	476
Moliere *Dumas* *Corneille* *Racine* *Jean Bart* *No. 6*	23,467	21.	12 12-in.	22 5.5-in.		10,580	10.8	542

The French and the Japanese evolved powerful designs, almost simultaneously, immediately after the *Dreadnought's* particulars became known, and both achieved the same end—a semi-*Dreadnought*

carrying four 12-inch and twelve 9.4-inch (10-inch, in the case of the Japanese) in lieu of the ten 12-inch on the British ship. This arrangement, shown in the diagram of the *Satsuma,* is identical with that of the earlier *Lord Nelson* and *Agamemnon;* this group of three types—British, French and Japanese—embracing ten ships, being the only semi-*Dreadnoughts* ever built, if we except the three Austrian vessels of the *Radetzky* class—smaller and inferior in every way. Many designers expressed a decided preference for this "semi-" design, with its two calibers of heavy guns, but it has now been abandoned on all sides in favor of the single caliber.

The newer French ships are similar in gun disposition to the *Rivadavia,* except that the wing turrets are not placed *en echelon.* In this respect they resemble the *Dreadnought,* for only ten of the twelve guns may be used on one broadside. The end guns, however, as in the *Rivadavia,* are mounted in the *Michigan* style.

THE JAPANESE SHIPS.

	Tons.	Speed.	Battery.	Broadside. lb.	Armor. in.	Length. ft.
Satsuma } *Aki* }	19,500	20.8	4 12-in. 12 10-in. 10 6 -in.	6,900	9.5	482
Kawachi } *Settsu* }	20,750	20.5	12 12-in. 10 6-in. 12 4.7-in.	7,570	12	479
Two new ships	22,000	21.	14 12-in. 14 6-in. 10 4.7-in.	9,425	12	500

The *Satsuma* type has already been outlined. The *Kawachi* and *Settsu* carry twelve heavy guns (some reports say fourteen, the two end turrets having three each) in six turrets, arranged as in the *Helgoland.* The original provision for these six turrets appears to have been the same as the present French disposition—an arrangement much superior to that now adopted.

Particulars of the two newer ships are uncertain. Much has been said about a fast design, similar to the *Indomitable,* but more powerful; this, however, does not appear to have gone beyond paper.

The Russian ships (*Gangoot, Petropavlovsk, Poltava* and *Sevastopol*) illustrated by diagram, are unusual in that they carry four three-gun turrets. Their main characteristics appear to be the very complete armor protection, especially on the bottom, as a safeguard against the torpedoes and mines which played such havoc with the Czar's ships in 1904 and 1905; and the arrangement of twelve 12-inch guns in four turrets. The ships are of 23,000 tons and 21 knots, are 590 feet long, and have an armor belt of a maximum thickness of 11 inches. The secondary battery consists of sixteen 4.7-inch guns; and the total broadside is 10,560 pounds. Work on the ships is reported

to be proceeding very slowly, because of difficulty in obtaining delivery of guns and armor, and it may be several years before they become available for active service.

The Italian ships, like the Russians, carry twelve 12-inch guns in four turrets; and the disposition of turrets is similar, all guns being available on either broadside. It is reported, however, that instead of each turret carrying three guns abreast, as in the *Gangoot,* there is virtually a double-decked or two-storied turret, carrying two guns below and one above. This would be somewhat similar to the double-decked turrets on the seven American battleships of the *Kearsarge* and *Georgia* classes, in which two heavy guns are carried in the lower or main turret, and two 8-inch guns above. The *Dante Aligheri* was launched September 17, 1910. She is of 19,000 tons and 22 knots. Her length is 500 feet, and her armor belt 9.4 inches in maximum thickness. The secondary battery includes eighteen 4.7-inch and sixteen 3-inch guns. The broadside fire is 10,705 pounds. The other three ships—*Conte di Cavours, Giulio Cesare* and *Leonardo da Vinci* —are to be longer (530 feet) larger (21,000 tons) and faster (23 knots).

The new Austrian ships are reported to be copies of the *Dreadnought.* The first two—*Tegetthoff* and *Kaiser Franz Josef*—have just been begun, but the others will not be laid down until next year. They are of 20,000 tons and 20½ knots, 500 feet long, and with 10 inches of armor. The battery is ten 12-inch and twenty 4.1-inch guns, and the broadside, 7,110 pounds.

The three Spanish ships—*España, Alfonso XIII* and *Jaime I*— are building in Spain from English designs. They are reduced *Indomitables* of medium speed (19½ knots) carrying, on a displacement of 15,700 tons and length of 440 feet, a battery of eight 12-inch and twenty 4-inch guns. The broadside is 7,110 pounds, and the armor belt 8 inches thick.

Interesting as being the first *Dreadnoughts* constructed in the United States for any foreign power, as well as for their sterling qualities, are the Argentine ships *Rivadavia* and *Moreno,* building respectively at the works of the Fore River Shipbuilding Company, Quincy, Mass., and the New York Shipbuilding Company, Camden, N. J. They share with the *Arkansas* and *Wyoming* the distinction of being the only really successful six-turret *Dreadnoughts,* from the point of view of broadside fire, yet put under construction. As shown by the diagram, there are four turrets at the ends, as in the *Michigan,* and two *en echelon* amidships, as in the *Indomitable,* thus giving a broadside of the entire twelve 12-inch guns, as well as enabling six to

be fired forward and six aft. The secondary battery includes twelve 6-inch and twelve 4-inch guns, the entire broadside being 10,998 pounds. The displacement is 27,500 tons; the length, 585 feet; and the speed, 22½ knots. The main armor belt is 10 inches thick amidships.

THE BRAZILIAN BATTLESHIP MINAS GERAES AT FULL SPEED.
Built by Sir W. G. Armstrong, Whitworth & Co., Ltd.

The three Brazilian ships are, aside from the Argentines, the only *Dreadnoughts* yet to be constructed outside the country to which they belong, though Chile is about to emulate Brazil in ordering construction in Britain. The first two Brazilians—*Minas Geraes* and *Sao Paulo*—have twelve 12-inch guns arranged much like those on the *Rivadavia,* except that those amidships can be used only on their own side of the ship, the broadside fire being from ten only. The secondary battery contains twenty-two 4.7-inch guns, and the entire broadside is 8,995 pounds. The displacement is 19,250 tons; the length, 530 feet; the speed, 21½ knots; the armor belt, 9 inches thick.

The third ship—*Rio de Janeiro*—is an enlarged copy of the *Rivadavia,* having a displacement of 32,000 tons, a length of 655 feet, and a speed of 22½ knots. Her battery consists of twelve 14-inch, fourteen 6-inch and fourteen 4-inch guns, giving a broadside of 17,717 pounds. The armor belt is 9 inches thick. This is the largest warship ever laid down, as well as the most powerful, being the first to pass 30,000 tons in displacement, and 15,000 pounds in broadside.

As illustrating a possible method of mounting sixteen heavy guns, of which fourteen may be used upon one broadside, the writer last spring submitted to the United States navy department a sketch of a 32,000-ton ship, shown in diagram, which presents some points of interest. The ship was designed for a speed of 21 knots. The main armor belt, 12 inches thick at the waterline, tapers to 9 inches at main deck. The length is 640 feet; breadth, 98 feet; draft of water, 30 feet. The battery, which is the heaviest ever seriously proposed, consists of sixteen 14-inch, twenty-four 5-inch and twelve 3-inch guns, the total broadside being 21,990 pounds. This sketch we may provisionally call the *Alaska*.

SUMMARY OF DREADNOUGHTS AND SEMI-DREADNOUGHTS, BUILT AND BUILDING.

			Batteries			Broadside,	Average		
	Ships.	Tons.	12 in.	9 to 11 in.	3 to 7 in.	lb.	Speed.	Tons.	Broadside, lb.
England	25	477,400	220	20	485	211,068	23.15	19,096	8,443
Germany	17	341,000	132	56	474	138,608	21.88	20,059	8,153
France	12	250,722	96	72	228	104,892	20.34	20,894	8,741
United States	10	225,650	100	..	186	102,108	20.9	22,565	10,211
Japan	6	124,500	60	24	112	47,790	20.76	20,750	7,965
Russia	4	92,000	48	..	64	42,240	21.	23,000	10,560
Italy	4	82,000	48	..	136	42,820	22.77	20,500	10,705
Austria	4	80,000	40	..	80	28,440	20.5	20,000	7,110
Spain	3	47,100	24	..	60	21,330	19.5	15,700	7,110
Brazil	3	70,500	36	..	72	35,707	21.95	23,500	11,902
Argentina	2	55,000	24	..	48	21,996	22.5	27,500	10,998
Chile (to build)	2	48,000	24	..	48	21,972	21.	24,000	10,986
Totals	92	1,893,872	852	172	1993	818,971	21.68	20,585	8,902

Large size, in a battleship, is sometimes considered a case of "putting too many eggs into one basket." But it has much to recommend it, from the purely engineering standpoint—entirely aside from the *pride of possession* of a unit of the greatest size and power. Nature has made large activities more efficient—more economical in outlay, relatively speaking—than small ones. And one of the readiest proofs of this economic law is in connection with ships. Suppose, for the sake of example, we compare the 16,000-ton *Connecticut* with the 26,000-ton *Arkansas*, under the assumption that the former is required to attain the speed (20½ knots) of the latter.

To reach this speed under equal conditions of propulsion, the *Connecticut* would require engines and boilers capable of producing 23,900 horse power, which, on the basis of the weight (1,633 tons) of her present 16,500 horse-power machinery, would call for 2,370 tons, or 14.8 per cent of her own weight. But the *Arkansas* has machinery capable of producing this speed, and weighing 2,500 tons, or only 9.6 per cent of her weight. This saving of 5.2 per cent on the weight of the larger ship accounts for no less than 1,350 tons. If, however, the 23,900 horse-power engines of the revised *Connecticut* be turbines, as

A FULL BROADSIDE FROM THE BRAZILIAN BATTLESHIP SAO PAULO.
Built by Sir W. G. Armstrong, Whitworth & Co., Ltd. She is firing ten 12-in. and eleven 4.7-in. guns.

in the *Arkansas,* the weight would be only 1,810 tons, or 11.3 per cent; and the saving in the larger ship would be reduced to 1.7 per cent, or 440 tons.

The armor of the *Connecticut* weighs 3,992 tons. To cover an equal proportion of the area of the larger ship with armor of the same schedule of thickness, the weight would be increased in the ratio of the surfaces exposed, and would amount to 5,520 tons. This is 21.2 per cent of the 26,000 tons, as compared with 25 per cent of the 16,000 tons in the *Connecticut.* This saving of 3.8 per cent in the *Arkansas* represents 990 tons. Similarly, the fuel supply for equal steaming radius, and the equipment and stores, may be shown to represent potential savings of 210 and 180 tons, respectively. The aggregate saving on these four items, on the basis of turbine machinery, is seen to be 1,820 tons, which figure is increased to 2,730 tons, if the reciprocating type of machinery of the *Connecticut* be retained.

Now, as to what could be done with this available weight on the *Arkansas*—

	Tons
Four 12-inch guns, with mounts and ammunition	500
Armor protection for same	350
Extra fuel supply	500
Extra hull armor	470
Total	1,820
Four 12-inch guns, mounts, ammunition and armor	850
Extra ammunition	60
Total	2,730

This is a purely imaginary computation concerning the relative weights which the *mere size* of the larger ship saves, as compared with what the requirements of the smaller one demand. It is simply illustrative of the value of size, as an asset of the naval designer; and serves to explain, in some measure, the reasons operating towards a steady increase in size of ships—a sort of progression which is already taxing our harbor and docking capacities almost to the limit.

Another sort of comparison might be instituted between ships of the *Connecticut* class—the latest pre-*Dreadnought* type in the United States—ships of the *Delaware* class—the first of the American high-speed *Dreadnoughts*. To obtain tonnage equality, let the comparison be between five *Connecticuts* of 16,000 tons (80,000 tons, total) and four *Delawares* of 20,000 tons (also 80,000 tons, total). In the first place, the superior speed of the latter (21½ knots, as against 18½) would enable them to maintain whatever distance (battle range) might be considered most suitable; and this would doubtless be one at which the 8-inch and 7-inch weapons, with which the sides of the *Connecticut* fairly bristle, would be unable to inflict serious damage. In this case the available broadsides would be twenty 12-inch guns from the *Connecticuts*, and forty 12-inch guns from the *Delawares*. The armor protection being also somewhat in favor of the latter, the result of an engagement could not long remain in doubt.

If, however, a closer range were forced by circumstances upon the *Delawares*, their broadsides would be augmented by twenty-eight 5-inch guns, giving them a grand total of 36,840 pounds of metal; while the fire of the *Connecticuts* would be increased by twenty 8-inch and thirty 7-inch guns, giving here a grand total of 27,550 pounds of metal. But, even in this case, there could be little doubt as to the outcome, for the smaller guns could not penetrate the heavy armor protecting the vital portions of the ships of either fleet; and the main brunt of the argument would still be maintained by the 12-inch weap-

ons, with 34,800 pounds opposed to 17,400 pounds. In addition, the concentration of the guns of the four *Delawares* would be much greater than in the case of the five *Connecticuts;* for, assuming a spacing of 400 yards of clear water between ships, the five smaller vessels would cover a total of 2,350 yards, as compared with 1,880 yards for the four larger ships. So, from the point of view of effective gunfire, the *Dreadnought* idea appears completely vindicated.

The subjoined table gives particulars regarding the broadside fire of eighteen representative types already described, showing also the broadside in pounds per thousand tons of displacement, the proportion which the broadside bears to the total possible fire, and the mean arc of the circumference through which the main battery guns may be trained.

Type.	Displacement, tons.	Broadside, lbs.	Broadside, per 1000 tons.	Broadside, per cent of total fire.	Mean arc of fire, degrees.
*Dreadnought**	17,900	7,000	391	79	216
Neptune	20,400	8,965	439	98	258
Orion (A)	23,500	12,965	552	98¾	261
Lion	26,350	10,434	396	98	260
Michigan (A)	16,000	7,114	445	98	280
Delaware (A)	20,000	9,120	456	95½	280
Arkansas (A)	26,000	11,040	425	94½	285
Oklahoma (A)	29,000	14,600	504	96	280
Alaska (*A)	32,000	21,990	687	85	245
*Nassau**	18,700	6,888	368	64	190
*Helgoland**	21,000	8,800	419	64	190
Moltke	19,500	8,656	444	91½	260
*Danton**	18,320	6,902	375	69½	b
*Molière**	23,467	10,580	451	77	240
Gangoot	23,000	10,560	459	96½	260
Rivadavia (A)	27,500	10,998	400	93	283
*Minas Geraes**	19,250	8,995	467	80½	240
Rio de Janeiro (A)	32,000	17,717	554	95	283

* Part of battery masked. A—American in conception. b—Mixed battery.

An inspection of the table will show how the broadside percentage to the total fire falls off as soon as part of the main battery is mounted behind a superstructure—as in ships designated by an asterisk. It also shows how much more powerful are the American secondary batteries than those of most of the other nations(See 94½ and 95½ per cent for the *Arkansas* and *Delaware,* as compared with 98 and 98¾ per cent for the *Neptune* and *Orion*) all main battery guns in each case training on one broadside.

If we average the eight cases where the battery arrangement is of American conception, it is found that they show 512 pounds to each 1,000 tons of displacement, as against 422 pounds for the average of the other ten designs. None of the purely European designs shows more than 260 degrees for the main arc of training; only one American design is below that figure.

Among the special problems which have been produced by the advent of the *Dreadnought* is that of providing for adequate safe-

guards to prevent the fire of one turret from damaging another. A system of danger signals, giving loud and characteristic warning in turrets when the training of the guns is such as to endanger those of a neighboring turret, has been fitted to many ships, of which the original *Dreadnought* was, quite naturally, the first. Methods of measuring accurately the distance of a hostile ship or a target have necessarily to be carried to much greater nicety.

Special masts have been evolved for carrying these position and range finders and fire-control stations—masts which run practically no risk of being placed *hors de combat* by a single lucky shot. In Britain, this mast takes the form of a tripod of heavy steel tubes. The American skeleton masts are composed of small steel tubes woven into basket form.

But one of the most striking changes is in the simplification of calibers. Ten years ago it was quite customary to fit ships with a perfect museum of guns, so far as different calibers went. Now, all this is changed. Thus, the Russian battleship *Jevstafi* (1903) is listed as carrying four 12-inch, four 8-inch, twelve 6-inch, fourteen 12-pounder, six 3-pounder, six 1-pounder and two 2½-inch (boat) guns, or a total of seven different calibers. The Italian *Regina Margherita* (1901) has almost identically the same battery, also of seven calibers. On the other hand, the *Dreadnought* has ten 12-inch and twenty-seven 12-pounder guns, only two calibers.

In conclusion, some of the limiting conditions affecting increases in size may be pointed out. Draft of water is already a serious problem, for the harbors on the Atlantic and Gulf coasts of the United States are nearly all very shallow, few of them affording sufficient depth for present-day large ships. The Dutch and German coasts on the North Sea are equally hampered, as are various harbors in other parts of the world. Width is limited by entrance to docks, and, now, by the locks of the Panama canal. A clear width of 110 feet is here provided for, which would allow the beam to reach about 105 feet; but the latest vessels have already reached 98 feet. The Panama locks are 1,040 feet long, from center to center of gate pintles, which would here limit lengths to 1,000 feet. This has not been approached, nor is it likely that anything in the near future will do so. The 680 feet of the *Lion* and 655 feet of the *Rio de Janeiro* appear to mark what will probably be the extreme in length for some time to come. Not that progress in dimensions is at all likely to be stopped; but these two cases represent extraordinary steps, and the intervening gap between them and current practice bids fair to be bridged by the usual gradual development.

MODERN MACHINE SHOPS AND INDUSTRIAL PLANTS.

By Charles Day.

AN ANALYSIS OF SPECIFIC EXAMPLES.

Mr. Day's series of articles on the arrangement and construction of industrial plants, referred to in his opening sentence, began in the issue of THE ENGINEERING MAGAZINE for September, 1909, with a discussion of the preliminary work, detail plans and specifications, construction, and entry into occupation and operation. This extended through four numbers of the Magazine. The study was resumed in June and July, 1910, by two papers on "Metal-Working Plants and Their Machine-Tool Equipment," followed in September by one on "Routing as a Basis for Laying Out Industrial Plants." In the present issue he summarizes and illustrates the scientific method of attacking industrial construction problems, by a descriptive analysis of various typical establishments. This section of the treatment will be completed next month, and the entire discussion, revised and enlarged, will then be put forth in book form under the title, "Industrial Plants; Their Arrangement and Construction." It is the first thorough and authoritative treatise on the science of works construction to be offered to a professional and industrial audience.—THE EDITORS.

THE preceding series of articles in this series dealt with the "method of procedure" that should be followed when planning and designing industrial plants. Attention was directed especially to the physical requirements which are common to the efficient operation of all plants (irrespective of their output) and it was shown that these requirements can be properly solved for all cases only by those who have a thorough knowledge of the fundamental principles that pertain to every industrial activity. This treatment of the subject was so broad as to preclude the opportunity of direct reference to the characteristics of individual plants. Subsequent articles considered the more special necessities of that group of industries in which the working of metals predominates, and in this instance different types of buildings were illustrated, but described only insofar as they were characteristic of types or representative of certain general classifications, determined by output, without reference to their individual peculiarities.

I have not touched upon the innumerable methods, processes, and procedures that are special for given industries, except as covered by my articles relating to the metal trades and a brief allusion to the hat industry. It is obvious, however, that it is imperative when planning a workshop to have not only a thorough knowledge of the

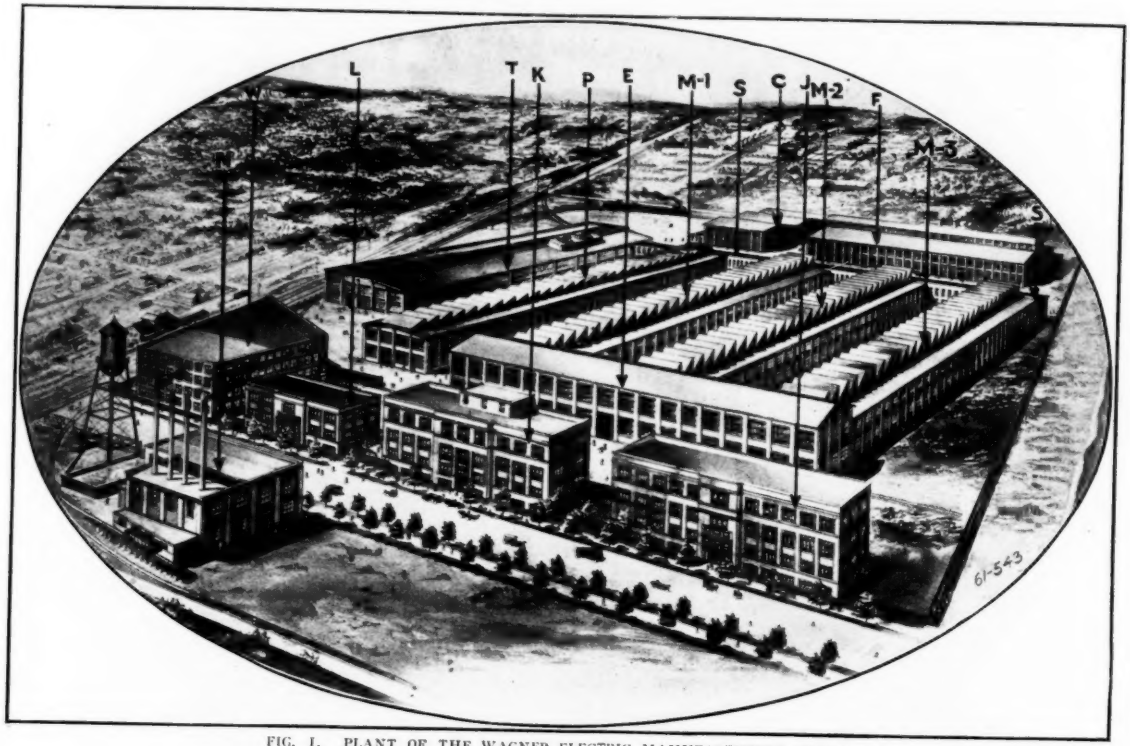


FIG. I. PLANT OF THE WAGNER ELECTRIC MANUFACTURING COMPANY.

detail processes that will be performed, but also a vast amount of data relating to the proposed business policy of the management. This phase of the entire subject comprises the whole range of industrial handicraft and business policy.

The only way that an adequate idea can be imparted of the interrelationships and far-reaching influences of all the factors involved, would be to describe in full detail the course of reasoning followed when working up some one complex layout; but space is inadequate to give a complete exposition of the aims, purposes, and methods of even a single business, to say nothing of the uses made of such knowledge as a primary basis for the planning and designing work. However, it would seem fitting, as a closing article to this series, to discuss briefly a number of modern industrial plants which have been laid out substantially in accordance with the methods advocated. Even if the whole story cannot be told, attention can at least be directed to the more interesting features that they possess, and in this way I hope to emphasize the real significance of certain of the matters contained in the earlier publications. With this explanation (which I hope will prepare the reader merely for the presentation of the various points of considerable interest presented by the plants herein illustrated, rather than a logical recital of the manner in which the results were brought about), we will proceed with the first example, which is the large plant of the Wagner Electric Manufacturing Company, St. Louis, Mo., builders and manufacturers of a wide variety of electrical apparatus.

Figure 1 shows in perspective the exterior appearance of the ultimate development of the plant that was finally agreed upon by all parties engaged upon this work. At the time this perspective was made the property was held under option only, there being no structures located upon it. We need not dwell upon the necessity of selecting a new site, as the accommodations occupied previous to the construction of the new plant were wholly inadequate for the volume that the business had already attained, leaving out of consideration a very material increase which trade conditions made immediately imperative. Further, the location in question was only one of a number that were taken under consideration, so that in this particular (and I might say in almost every other respect) there were no limitations imposed that interfered with a correct procedure in connection with the preliminary service. The perspective drawing, Figure 1, is of the ultimate development, and so illustrates a plant considerably larger than the one provided by the

company at the time the first construction work was carried out. In this regard "factors" representing the increase in capacity desired immediately, as well as those representing the probable increases that would be required from time to time up to the estimated ultimate development, were carefully figured in advance, and adhered to throughout the work.

The more important divisions of the product are alternating- and direct-current motors and generators, covering practically the entire range of capacity for which there is demand, transformers of all sizes, auxiliary electrical apparatus such as starting devices and switchboards, and alternating-current electrical measuring instruments. A condition of the work was that the growth of the business would entail merely a greater output in connection with each of the lines just referred to, rather than the probable addition of other lines of manufacture. Therefore, it was necessary to provide for only such departments as already existed, at the same time making provision for the necessary expansion in these departments to meet future requirements. The brief description that follows gives a general idea of the plan of manufacture.

A very considerable amount of cast iron enters into the product, and for this reason a foundry is provided on the layout that will be adequate for the complete development. The raw material for this foundry is delivered on the siding that passes to the rear of the property as observed from the point of view assumed by the perspective drawing. After the castings are made in foundry "F" they are transported directly across an open way to building "S," which is the raw-material store house, extending across the rear ends and communicating with all the manufacturing and assembling buildings. All castings, therefore, must go through the store house before getting into the shops, so they are properly checked up and recorded on the balance of stores record and, if not needed immediately, they remain in this department. All other raw materials are received on the siding that is shown entering the property at the upper left-hand corner of Figure 1, and as it passes directly alongside of the stores building "S," the various incoming materials can be unloaded and carried to their respective bins, racks, or compartments, with the entailment of a minimum expense. This stores building is a two-story structure, the first floor being on the same level as the floors of the main shops, and the second floor on the same level and communicating with the galleries of the main shops, which are shown in the interior view of building "M-1" (Figure 2).

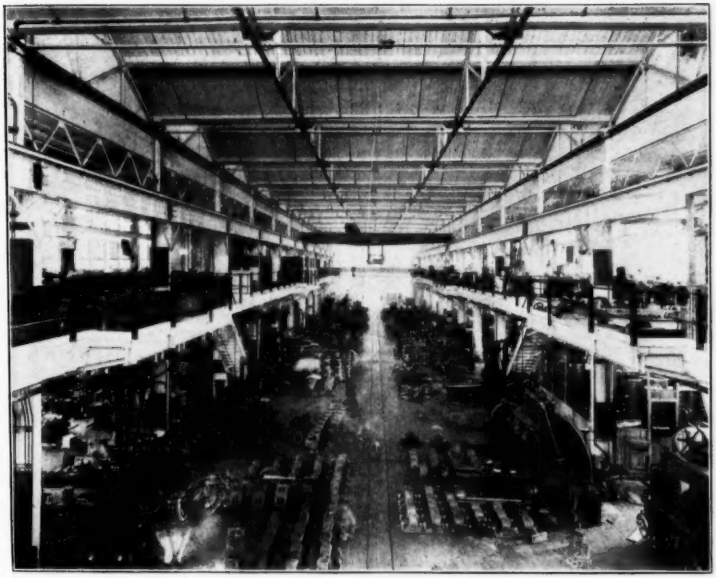


FIG. 2. INTERIOR VIEW OF ONE OF THE MAIN SHOPS OF THE WAGNER ELECTRIC MANUFACTURING COMPANY.

In each case the raw product is stored as conveniently as is possible with regard to the building to which it must ultimately be delivered for the performance of the first manufacturing operations.

As the manufacture of sheet-metal laminations is a function that is common to alternating-current motors, generators, and transformers, building "P," known as the "punch department," was provided for this purpose. Directly adjoining this department and extending into the area way between buildings "P" and "M-1" is located the annealing department, the floor level of which is 11 feet 6 inches below the first-floor grade of the main shops. The purpose of this arrangement will be better understood by referring to Figure 3, which is an interior view of a tunnel, extending directly across the plant, perpendicular to buildings "T," "P," "M-1," etc., and located about midway between buildings "S" and "E."

After the laminations have been pressed out they are lowered on an elevator to the annealing department which is on the same level as the tunnel floor. If the annealed laminations are intended for the transformer shop, building "T," they are wheeled through the tunnel to the elevator communicating with this building, and in the

same manner access is given to buildings "M-1," "M-2" and "M-3" without the necessity of going out of doors or in any way interfering with other work which would be the case if loaded trucks were being pushed constantly through the various shops.

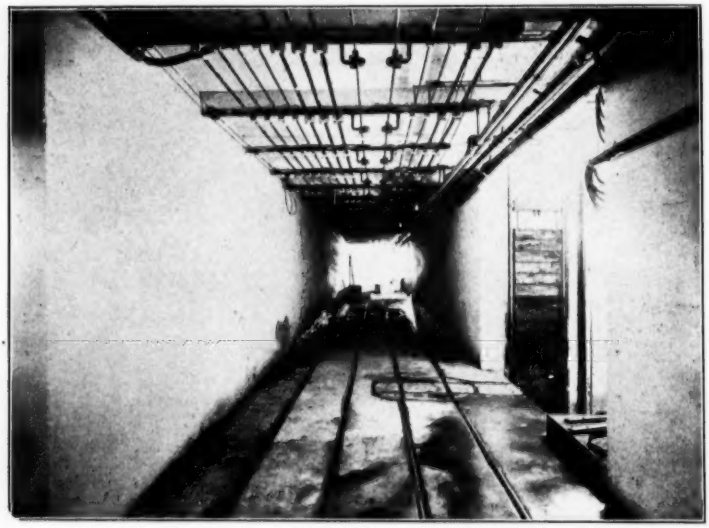


FIG. 3. TUNNEL TRAVERSING PROPERTY OF WAGNER ELECTRIC MANUFACTURING COMPANY.

Motors and generators of various sizes are now made in building "M-1"; the gallery floors and certain sections of the main floor being used for manufacturing work, the machining of large parts, winding, etc., and the balance of the floor space for erection and testing purposes. Building "M-2" will be used for essentially the same class of work, and building "E" for the erection of the largest types of machines that are built. Building "M-3" was provided in the layout to take care of the work on parts and group assembling for the largest product that the company is likely to turn out, and owing to the uncertainty of its character no attempt was made to apportion its space or to determine finally upon the characteristics of the building. Building "J" was provided for the manufacture of electrical instruments; building "K" is the main office; building "L" the service building for employees, and "W" a warehouse for finished product.

The work performed in this plant can be divided roughly between the first two of the three broad classes of metal working discussed

in a previous article. The instrument work should be classified under the first division as it is strictly a manufacturing proposition. The building of large motors and generators comes under the second division, as it comprises a definite line of comparatively heavy machinery. Cross sections of buildings "T" and "M-1" were included in the article in question as illustrating the special character of buildings designed for heavy work. It is only necessary to glance at Figure 2, which is an interior view of building "M-1," to see that the character and dimensions of this shop have been governed in practically every detail by the requirements of the work to be performed in it, and that in many particulars the structure of the building forms the function of equipment. This is true not only in connection with the crane runways, the supports for overhead monorails, and the provisions for elevators, but also in connection with certain features of the equipment proper.

The layout that we are considering is characterized by a series of shops arranged parallel to one another, and connected at one end by a raw-materials storage building, and at the other end by an erection shop, except in the cases of the transformer department, from which finished transformers are shipped direct, and the punch department, which serves the machine shops but not the erection department. Flexibility is secured through the possibility of erecting additional shops paralleling those first erected and at the same time extending the stores and erection departments, so making the additional units an integral part of the plant as a whole until such time as the full development, as illustrated by Figure 1, is attained. This general scheme is by no means new, having been resorted to frequently before the Wagner plant was built, one of the best known illustrations being the plant of the Allis-Chalmers Company at Milwaukee.

Provision was made to segregate all the foundry workers from the employees of the other departments, a condition which is in many cases desirable in order to gain an adequate control of the labor situation. The employees of all departments other than the foundry enter the plant through the service building "L," where they dress for their work before going to their respective departments. The time of commencing work, however, is in each case recorded in the departments where they are employed, a condition which is of considerable importance in all large plants. Separate service facilities and entrance and exit to the property are provided for the foundry operatives.

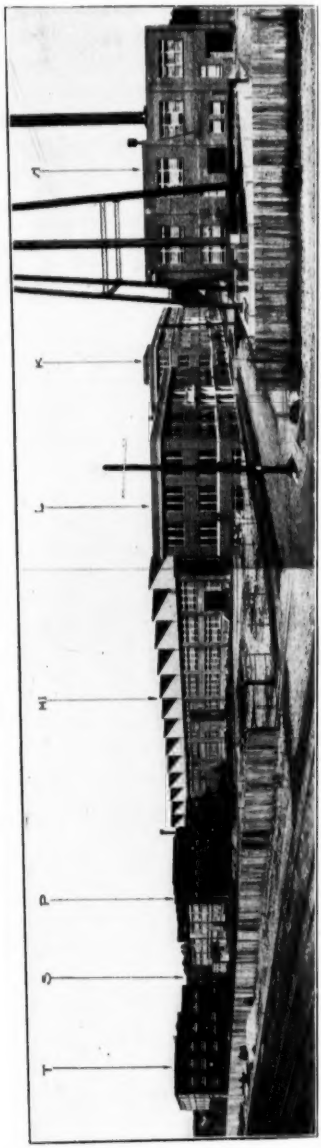


FIG. 4. FIRST CONSTRUCTION WORK IN CONNECTION WITH NEW PLANT OF WAGNER ELECTRIC MANUFACTURING COMPANY.

Figure 4, which is a photograph of the plant immediately after the completion of the first stage of construction, shows clearly the manner in which the necessities of the company as existing at that time were provided for. Buildings "Y," "P," "S," and "N" were erected in part only but buildings "M-1," "K" and "L" were built as shown on the ultimate development. The temporary ends of buildings "T" and "P" appear in the foreground. Construction of the instrument building "J" was deferred, this work being efficiently provided for upon the second floor of building "P." It was purely special conditions, arising principally through the difficulty of acquiring certain property, which resulted in the location of the power plant, building "N," upon a separate plot, but when the necessity for doing this arose, it was found that no serious objections were presented from the standpoint of power generation and distribution, whereas it appeared that the future would probably develop the need of the property adjoining the power plant for the construction of a multiple-story factory.

A very important consideration that always confronts the industrial engineer is the character of buildings that should be adopted for different purposes. There are usually certain limits of expendi-

ture that are possible, the lowest of which must at least allow of the reasonably efficient performance of the industrial work, whatever it may be, whereas the upper limit represents an expenditure that meets not only the shop requirements proper but those incident to the provision of buildings of a thoroughly permanent character and attractive appearance, incorporating also all the refinements in furnishings and appliances that form a consistent part of such structures. The very nature of some businesses is such that they should not be handicapped by the interest charges that would follow the adoption of recommendations based upon what I have termed the upper limit of expenditures; and in other cases, aside from the utility that the greater disbursement may represent, it is impracticable to secure the necessary funds.

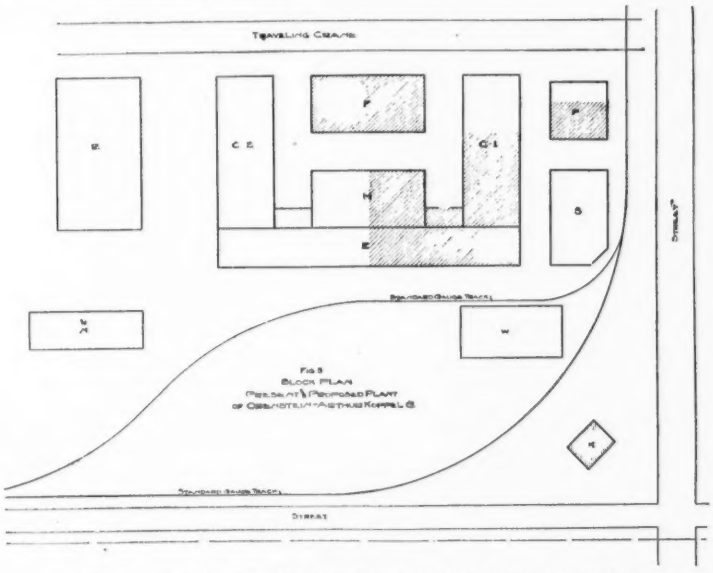


FIG. 5. PLAN OF PROPERTY, ORENSTEIN-ARTHUR KOPPEL COMPANY.

The new plant of the Orenstein-Arthur Koppel Company, built a few years ago at Koppel, Pennsylvania, and recently enlarged in capacity, is a good illustration of an instance where every dollar that was spent went for some positive utility. The plan of ultimate development of their property is illustrated by Figure 5, and Figures 6 and 7 are photographs showing the plant as a whole, prior to its enlargement, and the interior of the erection shop, respectively.

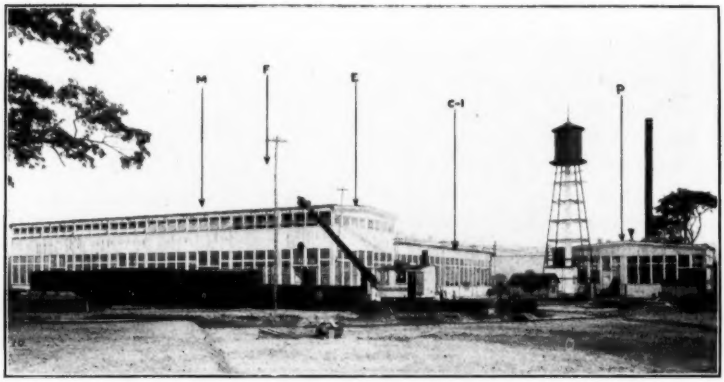


FIGURE 6.- PLANT OF ORENSTEIN-ARTHUR KOPPEL COMPANY, KOPPEL, PENNSYLVANIA.

This company manufactures high-grade contractors' equipment, including principally dump cars of all kinds and industrial-track systems. The labor cost per pound upon this product is very low, so it is absolutely imperative that the cost should be burdened with a minimum overhead expense; for in any case it will be a considerable part of the total cost, and unless this condition of minimization were complied with the company would occupy a vulnerable position. It was on this account that practically everything was made subservient to utility insofar as this course was reasonable when designing and building the plant of Orenstein-Arthur Koppel Company.

Buildings "C-1," "C-2," "F," "M" and "E" form a complete group for the manufacture of the entire range in capacities of industrial cars of many different types. The raw materials, which comprise principally sheet steel and structural shapes, are received on the siding passing between building "P" and the property line and are unloaded by means of a gantry crane and carried by this crane to the proper section of the storage yard. Building "C-1" is known as the light car shop and building "C-2" as the heavy car shop; the structural and sheet-metal work as well as certain preliminary assembling operations being performed in these departments upon the respective divisions of the product. These shops are served by cranes that operate lengthwise of the buildings and on either side of the central row of columns.

Building "F" is the forge shop, which serves about equally the light and heavy car work, and building "M" is the machine shop which serves buildings "C-1," "C-2," and "E," the latter being the

erection shop, an interior view of which is shown in Figure 7. It will be seen that the arrangement of departments reduces the handling of material to a minimum, a condition which also makes for the most ready supervision of the work. There is no dividing wall between building "M" and "E," and by locating the tool room in building "M" directly adjoining the erection department, as shown in Figure 7, it is made most accessible to all the departments it serves. Building "R" was provided for the frog and switch work, building "S" for the storage of miscellaneous raw materials, and an office building "K" was provided which does not show in the photographs.

The first construction work that was carried out by this company included the erection of the buildings which are cross-hatched on Figure 5. However, the plant has been extended since that time. All the equipment is motor-driven through the medium of either the direct or group method. The power plant, building "P," contains direct-connected generators delivering to the various departments direct current at 220 volts, a three-wire system being used for the lighting. Wherever the requirements made it desirable, adjustable speed motors were installed.

FIG. 7. INTERIOR BUILDING "E," ORENSTEIN-ARTHUR KOPPEL COMPANY.

The interior view of the erection shop, Figure 7, gives a general idea of the type of building construction that was used throughout the plant. The crane runways are supported on a steel frame which carries the roof. The cost of the side walls was minimized and at the same time admirable natural lighting procured through the use of a concrete base course extending from the footing up to a point 6 feet above the floors, and above this base course, extending from column to column, are the window frames, designed for balanced sash in the lower sections. In the case of the erection shop an additional row of tilting sash was installed above the crane runway. This type of construction eliminates entirely the usual pilasters between the window frames. The floors of the various shops are composed of 6 inches of bituminous concrete upon which is laid a 3-inch under floor covered with ⅞-inch factory-grade maple. The roof is composed of heavy plank laid on steel purlins and covered with a form of flexible roofing material.

The greater part of the finished product is stored prior to shipment in the yard directly in front of building "E" and a locomotive crane is used for handling it. A finished-product warehouse building "W" is also shown on the layout. The conclusion that one invariably reaches upon visiting this plant is that money has not been skimped in any particular that makes for economy of operation, whereas not a dollar has been spent for the sake of appearance alone. While this policy was undoubtedly the correct one to pursue in this case, it would of course be wholly inconsistent with the requirements of many other businesses.

SYSTEMATIC FOUNDRY OPERATION AND FOUNDRY COSTS.

By C. E. Knoeppel.

IV. PRODUCTION AND ITS DETAILS.

In the article inaugurating this series, published in October last, Mr. Knoeppel outlined the elements of the foundry problem. His second paper discussed thoroughly the very important question of depreciation as its comprehension applies especially to the profitable conduct of a foundry business. In December he took up the remaining elements to be recognized in foundry organization and accounting and defined the character and limits of each. His fourth instalment takes up the problems of production and the systematic treatment of the conditions that affect the actual productivity of the workman and the foundry.—THE EDITORS.

IT has been said many, many times, that the aim and purpose of a cost-accounting scheme, is *to increase production and reduce costs,* and unless these are the results, the arrangement must naturally be judged a failure; and because this has not been the attainment in so many instances, "cost accounting" is looked upon as something beautiful in theory but failing miserably in actual practice. The regrettable feature about it all is that there seem to be sufficient grounds for this feeling, notwithstanding the fact that there ought not to be.

A prominent foundryman recently told me that in the plant in which he is employed, elaborate accounting methods were devised and installed (at no small cost) and an elaborate force organized to compile accurate and detailed cost data (also at no small cost). He stated that results were made known so long after the performances covered by the records, that it was simply an impossibility for him or anyone else to point out reasons for certain fluctuations in costs; and that as a matter of fact, he knew more about what was going on before the introduction of the methods than he did after their installation. If this is not paving the way for a long string of excuses, enabling those responsible for inefficiencies to hide behind the much used "I don't know," then it would be a difficult task to ascertain what would be.

As has been stated before in this series—an accounting arrangement is a *recording* agency, not a *producing* agency, and if this recording is not a reflex of the existing conditions, then how can it

be expected that one or a few men will know what caused this and what caused that? At any rate a close study has convinced me that accounting schemes fall down *because of the many things the cost statistics do NOT show.* Without questioning the theory of accounting, without doubting the accuracy of the recorded data, we must all agree that any system of records should show where the faults are, enabling the executive to go to his management with facts explaining the figures *instead of asking them to explain the figures by substituting the facts;* which by the way, are most elusive.

The reason for all this seems to be the underestimation of the complications in the foundry business by those responsible for the installation of improved (?) methods. The fact that foundry work is made up of four principal operations—moulding, core-making, pouring, and cleaning, is no indication that the proposition is as simple as many seem to think; but because of this seeming simplicity, or of lack of knowledge as to details, methods have been introduced in the hope that the conditions should conform to them instead of their conforming to the conditions.

The principal element in the foundry business is its production, and it has been a source of wonder to me, why the details of this production have not been analyzed to see if they could be made to submit to some sort of uniform procedure instead of something which could be viewed about as one pleased. It therefore seems advisable to take up the discussion of production details in an endeavor to make this recording a *constructive* as well as an *analytical* force.

Working Conditions.—The first consideration is the conditions under which the work in a foundry is usually made, which as every foundryman will be able to appreciate, directly influence cost of production. A job may be made in an iron flask or in a wood flask that may have seen better days; it may be made in a flask of suitable size, or a flask may be used considerably larger than the work calls for. The pattern may be a mere skeleton which must be built up by the moulder before he can commence his moulding, or it may be a regular pattern, doing away with this extra work, or the pattern may be in the form of a sweep. One piece may be made in the flask, although it is just as likely that several pieces will be made in the same flask. The flask may consist of a cope and drag, or the drag may be dispensed with and the work made in a pit with a cope, or perhaps the cope and drag are both dispensed with and the work is made in a pit with loam plates for a covering, while for certain work we may see flasks consisting of drag, cheek, and cope. It

may be that on certain occasions work is made on moulding machines, but because of congestion at the machines is made on other occasions by hand. The work may be bedded in a pit or in a drag, or it may be rolled as when copes and drags are used. One time the work may be made in green sand, another time the decision will be to skin-dry the mould, or perhaps the order will be to make a dry-sand mould. Loam and sweep work also enters into the consideration as regards cost.

From the above it can easily be seen how difficult it is to comprehend what a cost really means unless some information as regards the working conditions is at hand; for in a shop of any size, having quite a variety of work, it is safe to gamble dollars to pennies that after a period of a few weeks, no one can tell with any degree of positiveness exactly how the work was made or what really caused certain fluctuations in cost. To get this feature down to a basis that will admit of the working conditions being an open book at all times, the following classification can be used to advantage in correctly defining how a piece of work was made—the prefixed letters being the designating symbols for the various conditions:

METHOD OF MOULDING-
- G—Green Sand.
- S—Skin Dry.
- D—Dry Sand.
- L—Loam.

KIND OF MOULDING—
- B—Bedded.
- S—Swept.
- R—Rolled.

HOW MADE—
- M—Machine.
- H—Hand.

RIGGING—
- C—Cope only.
- DC—Drag and Cope.
- DCC—Drag, Check and Cope.
- LP—Loam Plates.

PATTERN—
- R—Regular.
- SK—Skeleton.
- S—Sweep.
- ..—Patterns to Gate. (Use correct numeral.)

(Designating Symbols for Conditions of Moulding; Continued.)

FLASK—

M—Metal.

W—Wood.

. .—Size. (List dimensions.)

If for instance a mould was made in dry sand; was rolled; made by hand; a cope and drag used; the work made from a regular pattern, two patterns to the gate; in an iron flask 5 feet by 3 feet by 2 feet 6 inches in size, the symbol would read:

DRH—DC—R2—M, 5×3×2-6

which would give anyone investigating the record a year from the time it was made, the exact facts in the case.

DELAYS.—Another feature which has never received a fraction of the attention it is entitled to is the matter of delays in the foundry, which are usually buried so deep in the cost figures as to be beyond all possibility of uncovering. Because of this I am of the firm opinion that the usual foundry accounting data cannot be anything else than inefficient because of the lack of clear and intelligible comparative evidence.

A moulder gets a job, we will say, and it takes him 24 hours to make it. According to the current practice, the moulding cost is $9.60, if the man receives 40 cents per hour. In this the correct cost? A moulder is hired *to make moulds*—not hired to do a great many things that he is oftentimes forced to do, which, in nearly every instance net the company absolutely nothing. If then in the 24 hours just mentioned, the moulder in question had lost any time for causes over which he had no control—causes which careful management could no doubt eliminate, *then the facts with their reasons should be properly recorded and classified,* for it is fair to neither the workman nor the job to tax it with what Mr. Emerson so aptly styles "preventable waste."

A point which it seems curiously difficult to bring to the understanding of managers accustomed only to "old-line methods" is that a large part of the gain obtained by efficiency methods comes from the elimination of these wastes. The skeptic as to "scientific management" has before his mind only the conception of driving the men to higher physical exertion. Efficiency methods, by reducing needless wear and friction, make the workman's task lighter instead of heavier. Actual acceleration of the workman's motions is the smallest part of the whole plan. Stimulative wage systems are the final step, and the least important as to exact method in detail.

Let us assume that the following is a time analysis of the job in question:

Number of Operation.	Operation.	Elapsed Time. Hrs.	Min.	
1	Getting sand in condition to start work	..	40	(*)
2	Waiting on bottom board and drag	..	15	(*)
3	Waiting on pattern	..	25	(*)
4	Placing bottom board and pattern	..	15	
5	Placing drag	..	10	
6	Ramming the drag	3	30	
7	Waiting on crane to roll drag	..	25	(*)
8	Rolling drag over	..	10	
9	Making joint	..	30	
10	Placing cope section of pattern	..	10	
11	Waiting for cope	..	20	(*)
12	Carpenters barring and chucking cope to suit the pattern	1	25	(*)
13	Placing cope	..	15	
14	Setting gaggers	1	00	
15	Ramming cope	4	00	
16	Waiting on crane to lift off cope	1	00	(*)
17	Lifting off cope	..	20	
18	Drawing pattern drag side	..	30	
19	Drawing pattern cope side	..	40	
20	Finishing drag	2	00	
21	Finishing cope	2	30	
22	Waiting on cores	..	30	(*)
23	Coreing up mould	2	10	
24	Closing mould	..	20	
25	Clamping and weighting	..	30	
	Total elapsed time on mould	24	00	

A study of this analysis reveals the fact that on starting the job in the morning, the moulder had to spend 40 minutes in cutting over his sand and getting it in condition for using. It then develops that he loses 15 minutes waiting for the laboring gang to bring in his bottom board and drag, after which because of some delay in the pattern shop, he is made to wait 25 minutes for his pattern. He then starts work and all goes well until he is ready to roll over his drag when he is forced to wait 25 minutes on account of the crane being in use elsewhere. After he rolls the drag and makes the joint, the next delay is 20 minutes, waiting for the cope to be brought to his floor. It is then found necessary to reset and chuck the bars of the cope so that it will suit the pattern that is being made, this taking 1 hour 25 minutes. He then works for 5 hours 15 minutes, placing his cope, setting the gaggers, and ramming, and when ready to lift off so as to begin the finishing of the mould, finds that the crane is

in use by some of the other moulders and that before he gets it, one hour has elapsed. Things go along nicely until he is ready to core up, but because of the cores being not quite ready is forced to wait 40 minutes. Listing these delays and we have:

			Hrs.	Min.
Operation	No.	1—Getting sand in condition to start work...	..	40
"	"	2—Waiting on bottom board and drag.....	..	15
"	"	3—Waiting on pattern.....	..	25
"	"	7—Waiting on crane to roll drag.....	..	25
"	"	11—Waiting for cope.....	..	20
"	"	12—Barring and chucking cope.....	1	25
"	"	16—Waiting on crane to lift off cope.....	1	00
"	"	22—Waiting on cores.....	..	30
Total time in delays.....			5	00

As a result we find that in the 24 hours, the moulder spent only 19 hours on work that can rightly be classed as "moulding," and 5 hours in delays—a clear waste, or at least the greater part of it. Assuming that in the 19 hours the man worked he did all that could be asked of him, then the ratio between the total elapsed time and the actual moulding time of 19 hours, is 78.5 per cent, consequently the loss or inefficiency of 5 hours is 21.5 per cent. If however the job had been standardized as a 15-hour job, then the efficiency would be but 62.5 per cent and the inefficiency of 37.5 per cent divided as follows:

Fault of the moulder.....16.0 per cent.
Fault of the management.....21.5 per cent.

If, however, the cost of the work is compiled on the basis of the 24 hours (as it no doubt would be) and is noticed on account of the length of time that was taken, we are virtually charging the inefficiency to the moulder, for after the costs are compiled *who in the place knows anything at all about the delays on this particular job?* The result is that the management attaches absolutely no blame to itself; the inefficiencies are lost sight of and the cost record filed away after the customary—"don't let it happen again." A statement of this kind, in the absence of pointing out any specific happening whose recurrence it is expected to avoid, is like asking a child to pick up something it did not drop.

Men should be encouraged to report delays that are preventable or for which they are not to blame, in order that they may be properly classified so as to *force action* in the direction of bettering conditions to eliminate the majority of delays that are usually met with in the foundry, which can be eliminated if the proposition is approached in the right spirit.

PRODUCTIVITY.—It is essential in any undertaking to know as much as possible about what is being accomplished, but it is equally important to have this knowledge condensed in as brief a form as will correctly convey the desired information. In the foundry business we deal to quite an extent with *weight*, and because of this fact the tendency has been, and is now, to indulge in too much consideration of "tonnage." Tons, tons, and more tons is the eternal cry; consequently who can blame the usual shop management because it suffers from "failing memory" as regards *light stuff* which cuts such a small figure in increasing tonnage; because it crowds work oftentimes regardless of cost; because it puts five or six men ramming a cope, in order to get the job out with a rush, when two men or three at the outside could work to decidedly better advantage.

Many an executive is perfectly satisfied when his statement shows a high tonnage for the reason that it is usually accompanied by a low relative cost and as a result it is considered that the attainment is up to the mark. It may sound very, very strange, but *it is this one feeling of satisfaction over high tonnage that has proven such a stumbling block in the way of attaining the highest efficiency in the foundry.* A large tonnage *because it is large* is in itself a direct factor in bringing about a reduction in cost, oftentimes regardless of any other consideration, and because of this fact it is a very easy matter for the inefficiencies to be lost sight of. Men may be working to disadvantage; the planning of the work may not be all that it should be; materials may be used recklessly; rigging may be used without much regard to its adaptability to the work; and yet "when the returns are all in," a high tonnage at a low cost overshadows the defects in the existing scheme of things. Reflection should show that it is possible for an inefficient shop to do a business at a profit so long as its tonnage can be kept above a certain figure, but once let it drop below the balancing point and an investigation of the inefficiencies is immediately in order. The trouble is that there is too much consideration given to figures in the aggregate—the final results; and as was pointed out in the introductory paper, the usual study of things begins at the wrong end—the top instead of the bottom.

To reverse the usual order of things, to be in possession of knowledge in condensed form, that will show how things are progressing, it is necessary to decide upon some unit that will convey more meaning than is usually conveyed by the final tonnage and cost statements. The law of cause and effect may help us. Production is the result of the work of the men who make it. Why not hitch the two ele-

ments together—the production *in pounds* and the work of the men *in time*, calling the ratio that it is impossible to ascertain, *productivity* —which would mean the relative amount produced in a given time? This would seem a logical unit for two reasons:—

1—Because the amount that a man produces in a given time is the basic factor determining the cost of what he produces.

2—Because it furnishes a unit of comparison as regards accomplishment.

The importance of the first reason will be appreciated upon consideration of the following:—

Case.	A.	B.
Weight of casting	250 lb.	250 lb.
Produced in given time (ten hours)	1,000 "	1,500 "
Labor rate per hour	$0.30	$0.30
Cost of the total amount produced in the ten hours	3.00	3.00
Cost of the total amount produced per 100 lb	.30	.20
Cost of the 250-lb. casting then becomes	.75	.50

NOTE—For a further discussion of productivity see the November, 1908, article of this series, on "The Importance of Correct Burden Apportionment."

As regards the second reason. Assuming the casting in cases A and B to be from the same pattern, it is evident that in the same length of time, the production at B was increased 50 per cent over that shown at A, consequently the man who made the six castings is a better workman than the one who made the four castings; or if the same man made the work, his productivity was better in one instance than in the other. Our unit of productivity takes into account the importance of both 1 and 2, whether the test is applied to a single casting, a group of castings, a division of the production, or the total amount produced.

The unit can best be expressed in terms of *pounds produced daily* and the rule would be:—

M = Hours of moulding.
W = Weight of casting in pounds.
H = Hours to the working day.
P = Productivity.

$$\frac{W}{M} \times H = P.$$

Some attempt has been made in a number of foundries to use this unit in getting at facts concerning production but it has been found that a decided difference of opinion exists concerning the elements

making up the unit. The time element has been found in certain cases to be:—

1.—The hours of moulders *only,* disregarding special laborers working as moulders, apprentices and laborers directly assisting moulders.

2.—The hours of moulders, special laborers working as moulders, apprentices and laborers directly assisting moulders.

3.—The hours of moulders, special laborers and apprentices laborers not included).

4.—The hours of moulders and coremakers because their time is considered a part of Direct Labor.

It naturally follows that each one of the four elements if used will give different results. One foundryman using No. 1 will tell another who may be using No. 4 that he is producing 1,000 pounds per man per day, and the second will say that he is getting 800 pounds per man per day. Both may be producing about the same amount, but the difference in the element used seems to make the practice of one foundryman much better than that of the other. If consideration is given to No. 1, it will be found that the relative expression of productivity is not absolutely correct; for while the moulders may be producing a certain amount, others have assisted the moulders to a greater or less degree in turning out the production, and the time of this assistance is as much a part of the producing time as that of the moulders themselves. As for No. 4, it will be apparent upon consideration that core-makers do not influence production as far as the core labor is concerned. The core setting by the moulders is of course a part of the producing time, the result of which is castings. Core labor, however, produces nothing of a tangible nature, and as the aim of our unit is to get at the relation between what is produced and the time in which it is produced, it seems reasonable to exclude the time of core-makers from our consideration of productivity. This leaves No. 2 and No. 3, either of which can be used, depending upon the policy in any certain shop, the procedure being as follows:—

1.—If the policy is to assign a laborer as a regular assistant to the moulder, then the time element should include the time of the laborer.

2.—If, however, the gang of laborers is a floating body, their time can be left out of the consideration.

It may be well to state in connection, that while the terms *productivity* and *efficiency* are in a sense synonymous, the above remarks on productivity must not be construed as meaning that considerations of efficiency are to be relegated to the rear. Efficiency, as was pointed

out in a previous paper, is the ratio existing between the estimated or possible performance and the actual attainment. A standard producing time against the actual producing time; the possible production against the actual weight produced, will give the relative degree of efficiency as to time or weight. The productivity ratio, however, considers *actual attainments only* and merges two *different* elements—production and time—instead of the same elements, so while there may seem a sameness in the terms, there is after all a difference in the two units of comparison. In papers to follow the importance of both efficiency and productivity, in their relation to the foundry industry, will be dwelt upon at greater length.

AVERAGE WEIGHT OF CASTINGS.—Another unit which can be used to advantage is the consideration of the average weight of what is produced in a given period and this can be employed with special reference to productivity. We sometimes hear that the reason for a high cost of production is the light work made, or if the cost is a low one, heavy work is given as the reason. The following rule will therefore give some information which may prove of value:—

W = Weight of the castings produced (in total or by classes).

N = The number of pieces made.

A = Average weight per piece.

$$\frac{W}{N} = A$$

It is a good thing to know that in a certain period of time the productivity was 800 pounds per man per day, while in another it was 1,000 pounds per man per day, but if in the first period it was found that the average weight of the castings was 800 pounds and 500 pounds in the second period, our information, which would naturally include a knowledge of the class of the work made, would be much more complete.

CLASSIFICATION OF PRODUCTION.—A general policy of classifying production should be adopted, along the lines suggested in the fifth paper of the previous series entitled "Apportioning Costs to Production in Various Classes of Foundries." To each one of the classes, a symbol should be given for use in charging and identifying the various classes. I doubt very much if it is advisable, except in extreme cases, to classify according to the individual pattern as this makes the costing altogether too elaborate and cumbersome, but I do believe in classifying by main classes having a limited number of subdivisions, with a proper provision for getting the production cost of any particular patterns if desired.

REINFORCED-CONCRETE BOILER SETTINGS.

By W. H. Weston.

In Mr. Weston's article, definition of practice rather than discussion of principles is the major purpose. In substance, he gives general working specifications for construction of the kind indicated by the title of his paper. His authority is derived from 18 years' experience in civil and mechanical engineering, including railroad work, steam-power plants, and waterworks.—THE EDITORS.

REINFORCED-CONCRETE boiler settings have not so far received very much attention from manufacturers and steam-power users, probably because owners and operators are waiting for what they consider the necessary experiments to establish the thing successfully as a valuable substitute for the present brick settings.

But the matter is not surrounded by difficulties of any kind, and there is no reason why these settings cannot be effectively built and used to advantage at the present time if the project is taken in hand in a practical way, and the knowledge that has already been gained about reinforced concrete is used. A setting built without any regard to the elements involved could not be expected to prove satisfactory in actual work.

Quite a large number of these settings have been installed, but of course the number is very small in comparison to the total of steam plants running. Reports from a number of the places where concrete is in use show a great range in the methods of construction and in the design of details, which indicates that many of them were built without much attention to the fundamental principles involved. But even at this, most of them are proving satisfactory to varying degrees, and it has not in any way been shown that a concrete setting cannot be made a success and an advantage in steam-plant construction. The matter sums up here, as in other things—in the long run, what will be the financial gain?

Many people apparently have the impression, when this kind of a setting is suggested, that it is intended to make the whole thing of concrete, and that the inner surfaces are to be exposed to the fire; but

of course with any kind of concrete as made at present such a construction is impossible. Fire-brick lining must be used as it would be for an ordinary brick setting, this being no disadvantage as far as the concrete part of the work is concerned.

There seems to be but little doubt that some of these settings in use at the present time were made of poor materials, that is, the materials although they might have been very good for ordinary purposes were not well suited to this work, and in other instances where the materials were all right and properly suited to the work, the proportions making up the mixture of concrete were not what is required to have the setting give the best results in actual service. These things are of very great importance in the matter and must be carefully and intelligently looked after to obtain satisfactory results.

Concrete made with gravel, even if the gravel is of the best as far as other uses are concerned, will not resist heat nearly as well as that made with trap rock; gravel concrete may at times crack and crumble where a hard trap-rock mixture will stay firm and solid. All soft rock must be avoided in the crushed stone, and also all limestone or rock of a similar nature.

The hardest and densest concrete usually conducts the least heat, and offers the greatest resistance to high temperatures. The sand should be clear and clean and have no admixture of vegetable or organic matter, clay, etc., and the particles must be free from any coating or film of dirt. When necessary the sand must be thoroughly washed. A uniform fine sand should not be used; one in which the particles range in size from those of fine sand to grains about ¼-inch is the best.

As to the size of the trap-rock properly suited to this work, it may be said that stone ranging between ½- and ¾-inch is preferable, and nothing larger than ¾-inch should be used. A first quality of trap rock should be had even if it must be shipped a long distance, because the close, dense grain, toughness and strength, make it more valuable than any other stone. Limestone, conglomerates, sandstones, etc., should not be used.

In any situation where trap rock cannot be had without involving too much expense, cinders may be used, although they are not to be commended as equal to broken stone. If cinders are used they must be of first-class quality; that is, the combustible matter must have been thoroughly burned out, and they must be free from dirt and soot. Ordinarily they should be screened to avoid these latter objectionable

elements, and the cinders must be so broken that no piece will measure more than 1 inch the largest way.

The proportions in the mixture for a boiler setting should be one of cement, two of sand, and four of stone; larger proportions of sand and stone should never be used.

If the concrete is to be made by hand, the cement and sand should be mixed together dry, the stone then added, and the necessary quantity of water supplied, all the mixing of materials dry and after wetting being done in the most thorough manner, the materials being turned over a sufficient number of times to produce a uniform mixture, the stone, sand and cement being evenly distributed throughout, and all surfaces of stone and sand thoroughly and evenly coated with cement and the whole mass uniformly wet. The water used must always be absolutely clean. The cement may be any of the standard brands of Portland.

As to the details of the setting, these can of course be varied more or less to suit given conditions, or form of boiler. But a study of a majority of those so far built gives a fair average result for common tubular boilers thus:

First; the walls are double, with an air space 3 to 4 inches wide (4 is preferable).

Second; the inner wall is about 5 inches thick (6 would be better) and the outer one 6 inches.

Third; both inner and outer walls are reinforced, and tied together.

Quite a variety of reinforcement has been used, but probably the best method is to use either 3/8-inch steel 5 inches on centers, both horizontally and vertically, or 7/16-inch steel 6 inches on centers. Short pieces of steel are placed transversely across the air space at the same spacing as the other steel, care being taken that the ends of these pieces do not come within 1 1/4 to 1 1/2 inches of the inner side of the inside wall. If the setting is properly built this will make ample reinforcement, give sufficient strength, and prevent cracks. Such reinforcement is simple, cheap, easily placed, and makes a good and satisfactory job when done.

With boilers of such design that the walls of the setting will be very high it would probably be necessary to build them somewhat differently from those for a tubular boiler, that is, in the matter of thickness and of reinforcement, and especially so if arches are to extend over the top of the boiler or any part of it that might cause a thrust.

A 4½-inch fire-brick furnace lining should not be used because on account of its thinness it must be bonded into the setting, and when it comes to the point where the lining needs renewing this bonding is a nuisance. On the other hand a 9-inch lining is thick enough to stay well in place without any bonding, and when it comes to renewing it, this can readily be done, for it is all straight work, and as there is no bonding the old lining can be torn out easily. This renewing of the fire-brick must of course be done whether the setting is concrete or brick. And another point is that a 9-inch lining is far better than a 4½-inch because it is heavier and more substantial, and also because it will not transmit as much heat to the outer setting. When the cost of tearing out and resetting a 4½-inch bonded lining is aken into account, it will be found that a 9-inch without bonding costs no more to build and reset, and in the long run that the latter is the cheaper because it will stay in commission longer.

Ample clearance should be had at the ends of the lining to allow for expansion.

When building around an economizer the double wall with air space is of course not necessary; a 5-inch wall reinforced the same as the 6-inch outer wall of the main setting with pilasters at the corners is sufficient unless it is intended to carry mechanical-draught equipment; if so, additional pilasters properly spaced must be used.

The corners of a single boiler setting, or those of the outer walls of a battery, should have pilasters 12 to 14 inches wide and about 15 inches thick at bottom; all pilasters to be reinforced.

In estimating the cost of a concrete boiler setting some allowance must be made for the locality, as the prices of labor and materials vary so much in different parts of the country. But taking a fair average, with a few exceptional localities left out, the price of the concrete part of the setting per cubic yard would be between $10 and $12, this price including the cost of the forms and of the reinforcement, or in other words, the total cost of the concrete complete in place. In figuring the volume of the concrete, the air spaces are to be figured in as though they were solid, and at these figures the total costs of a concrete and of a brick setting are about equal.

As stated before, the fire-brick lining must be used with either kind.

The cost of fire brick varies in the extreme from about $15 to about $45 a thousand, the variation usually being between $17 and $25, and a fair average price being $20 a thousand. At this figure the total cost of brick in place would average from $30 to $35 a thousand.

As to the comparative costs of a concrete and a brick setting it has been shown that the first cost averages practically the same. But in the long run the concrete will prove the cheapest, because if properly built it does not deteriorate so much as the brickwork, and it does not require the amount spent for repairs that is usually necessary to keep a brick setting in good condition.

The foundation for a boiler setting can invariably be made of concrete cheaper than of stone, and at the same time it makes a better one than those of random stone as usually built. And if an ash-handling plant is to be installed, the advantages of using concrete for this part of the work are its durability, and that it will cost less than brick or stone construction. Unless there is something especially complicated about it, such work can be done complete in place, including cost of forms, material, labor, etc., for about $8 per cubic yard. On some jobs it might run up to $10, even if the construction was fairly plain and simple, but $8 is probably a fair average for such work in most places, this price including the moderate amount of reinforcement needed.

Another advantage in using concrete for a boiler setting is the fact that at the present time it is being used to such a great extent in the construction of manufacturing plants that it is readily available for the boiler settings, and because the large amount of experience that has been gained in concrete work makes it a comparatively easy matter to adapt it properly to this purpose.

MINERAL RESOURCES OF THE JAPANESE EMPIRE.

By Dr. A. Selwyn-Brown.

In the following article Dr. Selwyn-Brown completes a review of the Japanese mineral industries, prepared from collated official and authoritative sources, and presenting a unique survey of the entire subject. It is of much importance in view of the growing claims of Japan to industrial rank. The former part, published in December, covered the resources and production of the Empire in copper and gold, with a digest of Japanese mining law.—THE EDITORS.

THE Japanese recognize that their agricultural resources are limited on account of the peculiar topographical and climatic features of the country. The agricultural land has been subjected to intense culture for centuries and cannot be improved much more. The Empire is thus precluded from becoming an important contributor to the world's food supplies. It will do well if it can manage to produce sufficient food products for its own use. When the population increases, it will necessarily become dependent upon foreign countries for food. Consequently, the administrators have for some years aimed at making Japan a manufacturing and shipping country. They have taken England as a model in doing this. Japan is not nearly so well endowed with natural resources as England is, but the progress lately made in developing Japan's shipping and manufacturing industries is remarkable.

It is almost essential for a nation aspiring to rank well among the great manufacturing peoples to command extensive resources of coal, iron, salt, the alkalies, petroleum, limestones and clays. Japan, fortunately, possesses an abundance of such resources and is therefore naturally equipped for becoming what her political leaders are striving for—the leading industrial country in the Orient.

COAL.

The coal resources of the Empire are extensive and statistics show they are undergoing a steady development. The collieries at present in operation have a greater capacity than is required for producing the quantity of coal needed for home consumption. An extensive export business in steam coals has, therefore, been built up with Chinese, Philippine, and South American ports. The annual production of coal in Japan since 1890 is shown in Table I.

IN THE NAKANO OIL FIELDS OF JAPAN.

TABLE I.—COAL PRODUCTION IN JAPAN, 1890-1909.

Year.	Long tons.	Year.	Long tons.
1890	2,608,284	1900	7,370,667
1891	3,175,844	1901	8,884,812
1892	3,175,670	1902	9,588,910
1893	3,319,601	1903	9,978,649
1894	4,268,135	1904	10,602,008
1895	4,772,654	1905	11,817,352
1896	5,019,690	1906	12,845,315
1897	5,188,157	1907	13,736,182
1898	6,696,033	1908	14,688,659
1899	6,721,798	1909	15,400,000

Workable coal seams occur right through Japan from Formosa to Saghalien and Corea. Coal is found in 43 of the 49 Prefectures of the Empire, including Saghalien and Formosa. It is estimated by the Geological Survey that the coal areas comprise over 1,000,000 acres of workable steam coal and 25,327 acres of useful lignite deposits.

The most valuable coal fields at present mined are situated on the small Island of Kyushu. The coal fields of Hokkaido, Honshu, the Southern Islands and Saghalien come next in order of importance.

The Japanese coal formations range in age from Mesozoic to Tertiary Times. Bituminous, semi-bituminous and semi-anthracite coal is mined. The seams are generally small and much disturbed by faults and by intrusive igneous-dike rocks. The coal is rarely of high grade. It is mostly a dirty steam coal rich in ash and sulphur.

The composition of the best Japanese coals is shown in Table II.

TABLE II.—COMPOSITION OF JAPANESE COAL.

Field.	Colliery.	Water. Per ct.	Volatile Matter. Per ct.	Coke. Per ct.	Ash. Per ct.	Sulphur. Per ct.	Coking qualities.	Specific Grav.
Chikuho	Shinnyu 3 ft. seam.	3.41	42.76	48.46	5.37	0.22	Good	1.311
"	Akaikie 5 ft seam.	2.64	43.99	50.44	2.93	0.41	"	1.275
"	Namazuta	1.66	42.50	52.68	3.16	0.81	"	1.298
"	Miike 8 ft seam.	0.70	42.15	48.85	3.30	3.34	"	1.278
Hizen	Takashima	0.98	39.08	53.42	6.53	0.65	"	1.270
Ishikari	Yubari	1.46	42.89	57.11	4.57	0.31	Fair	1.200
"	Poronai	5.09	42.19	48.80	3.92	0.25	"	1.306
Hitachi-Iwaki	Shiramizu	5.06	44.36	40.81	8.75	1.39	Bad	1.304

The Kyushu Coalfields.

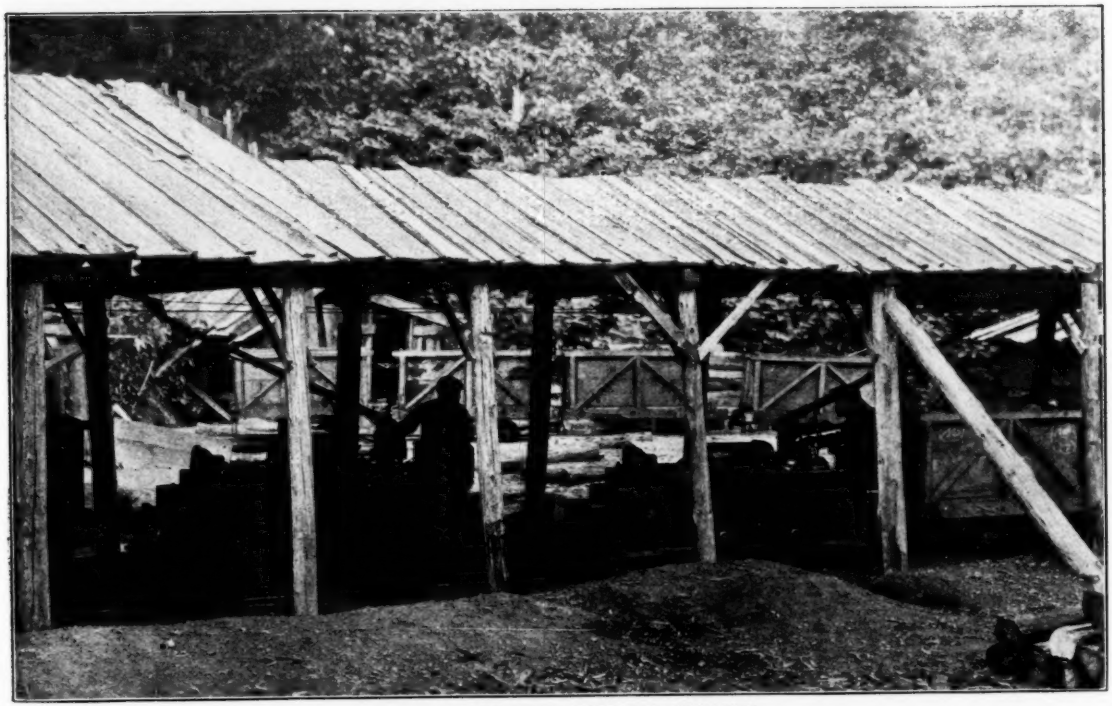
The principal coalfields in Kyushu are in the Fukioka, Saga, Nagasaki, and Kumamoto Prefectures. The Miike, the most productive field, is located near the seaport of Omuta, on the east side of Ariake Bay. The field has an area of about 30 square miles and is owned and operated exclusively by the Mitsui Mining Company.

The Miike coal beds are of Eocene age and are situated between shale and sandstone. Two seams are worked. One seam averages 6 feet and the other 8 feet in thickness. It is a bituminous coal containing about 50 per cent carbon, 40 per cent volatile matter, 6 per cent ash and 4 per cent sulphur as it comes from the mines. When it is hand picked, washed and screened, it assays, of course, better and gives results like those in Table II.

The Mitsui Company is operating six large collieries on this field and is doing a large amount of prospecting work with Calyx drills. The upper seam on the Miike field has a sandstone roof that lets in the sea water so that the colliery workings are very wet.

The coal is mined by shafts, the deepest of which is about 1,000 feet. The pillar-and-room system is employed in breaking out the coal. The worked out portions of the mines are filled in with stone-wall work filled with a mixture of mud dredged from Miike Harbor, crushed sandstone and boiler ashes. Little wonder rock drills are employed in drilling in stone-work and experiments are being made with various types of coal-cutting machines. The Manda colliery is the largest of the Miike group. The coal in this mine is worked through an inclined shaft 2,000 feet in depth. It is the wettest of Japanese collieries. The manager estimated that 10 long tons of water have to be baled out of the mine for every ton of coal mined. This immense inrush of water is handled by many types of pumps. The following pumps do most of the pumping: Three Davey 45 inch — 90 inch 22 foot by 12 inch differential; one Davey 45 inch — 76 inch by 22 inch by 70 foot differential; four 23 inch — 60 inch by 16 inch by 4 foot compound duplex Jeanesville; four 13 inch by 12 inch Knowles three-throw electric; one 6 9/16 by 11 13/16 electric Schleifmülle; three 10 inch Sulzer turbine; two 12 inch Sulzer turbine; thirteen 9 inch by 10 inch three-throw Sulzer electric and one 4½ inch by 5 inch three-throw electric. These pumps require 9,000 horse-power to operate them. The output of the mine is about 2,000 long tons of coal per day.

The company's other mines are furnished with similar pumps. Guibal, Sirocco, Walker and Champion fans are used for ventilation. The capacities of the fans range from 90,000 to 120,000 cubic feet



ELECTRIC LOCOMOTIVES, HOKKAIDO COLLIERIES.

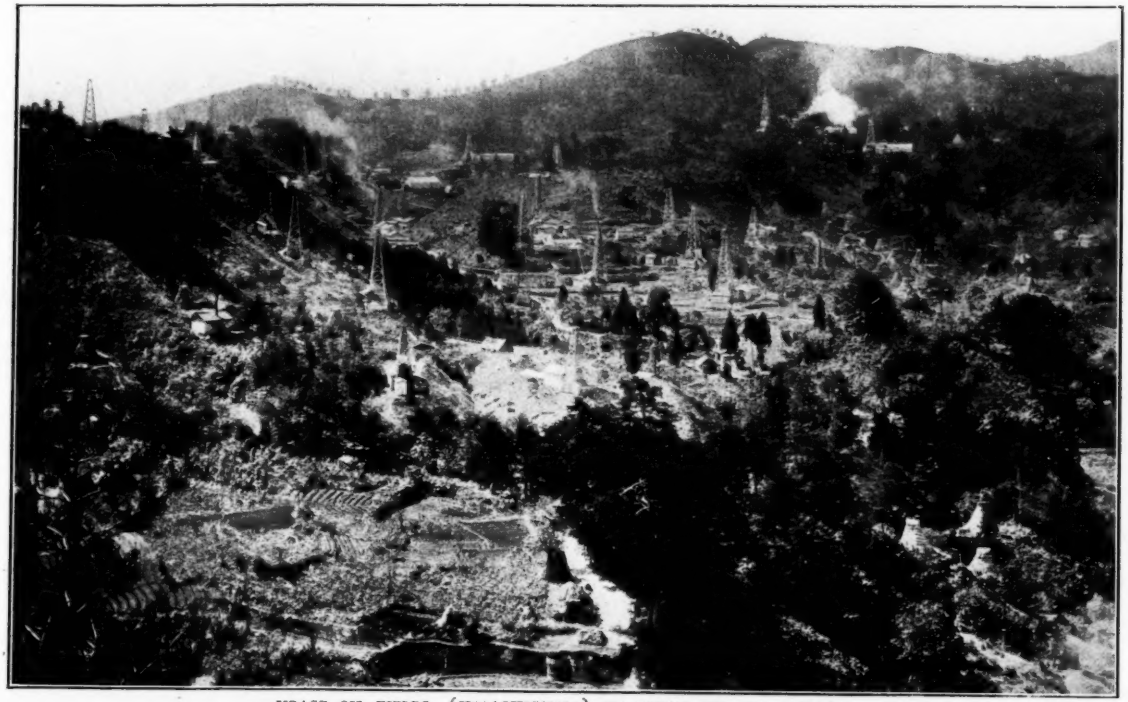
of air per minute. Lancashire and Babcock and Wilcox boilers are used for steam generation and the electric plant contains five Curtis turbo-generators. The steam-power capacity of the power works is 21,000 horse-power and the electric power averages about 5,000 horse-power. Work is found on the company's mines for 11,000 men and the annual production of coal is between 1,500,000 and 2,000,000 long tons. The company built an important harbor comprising 130 acres at Miike by means of concrete breakwaters. It is capable of permitting four 10,000-ton steamers to load coal per working day. This harbor is completely equipped with the latest appliances for automatically loading and stowing coal cargos.

The Chikuho coalfield is situated due north of Miike, and a little south of the port of Wakamatsu. The geological features of this field are similar to those at Miike. They really appear to be parts of one field that have been torn apart by a mountain uplift. There are numerous seams of coal in Tertiary, sandstone, slate and conglomerate formations. Over thirty collieries owned by various companies are working on this coalfield. The seams are mined by shafts and slopes. The slope in the Shin-Nyo mine is 5,400 feet in depth. The worked seams are from 4 to 6 feet in thickness and are mined by the pillar-and-room method. All the collieries are well equipped with ventilating and mining machinery.

The Saga coalfields are situated in the Hizen province, east of Miike. The geological features on these fields are also similar to those at Miike. All the coalfields in the western portion of the Island of Kyushu appear to be of the same geological age. They merely differ in their topographical aspects, and in the rock formations that prevail. These fields include the Miike, Kasuga, Chikugo, Saga, Nagasaki and Amakusa coal mining districts.

The Hokkaido Coalfields.

The second important division of the Japanese coal resources comprises the Hokkaido deposits. These include the Ishikari, Rumoi, Haboro, Wakanai, Poropets, Makunpets and Akkeshi fields. The principal collieries are working on the Ishikari field. This is situated in the province of the same name and a little east from the port of Sapporo. The field covers an area of about 600 square miles. The coal seams are in shale and sandstone country of Eocene and Miocene age. The numerous workable seams run from 2 to 5 feet in thickness. The coal is bituminous and averages 35 per cent volatile matter, 55 per cent. carbonaceous matter, 5 per cent ash and 0.5 per cent sulphur.



URASE OIL FIELDS, (HIGASHIZUMA) OF JAPAN OIL CO., ECHIGO.

The largest colliery now in operation is the Yubari. It has two working shafts cutting three coal seams. The main seam is 5 feet thick with bulges running up to 20 feet in thickness, and two 4 feet seams are mined. The pillar-and-room method of mining is employed here, as on most of the Japanese coal fields. The long wall system is rarely attempted owing to the broken nature of most of the seams. American rock drills and coal-cutting machinery and Guibal and Champim ventilating fans 20 feet in diameter are used at this colliery. The miners are furnished with the latest types of Wolf and Clanny safety lamps. The Japanese coal-mine inspectors strongly prohibit the use of the open lights in collieries that cause so many explosions in American mines.

The Yubari machinery is driven by steam, electric and pneumatic power. Lancashire and Babcock and Wilcox boilers are used as steam generators and Parson's turbines generate the electric power. The mine produces from 600,000 to 800,000 tons of coal per annum.

The Honshu Coalfields.

The coalfields of the Main Island are chiefly those known as the Fukushima, Ibaraki, Yamaguchi and Wakayama fields. There are several seams of Tertiary coal on these fields; but only two seams are worked. The coal is much disturbed by faults and igneous dikes. It is of poor quality and in places is almost a lignite. The ash runs from 8 per cent to 17 per cent and the sulphur content is about 2.5 per cent. The coal is principally used in lime-burning and in cement-manufacturing works.

The Japanese Navy officials are developing the Omine collieries on the Yamaguchi coalfield, with the view of raising coal for naval supplies.

The Southern Islands Coalfields.

Coal is mined in small quantities in several districts in the western and northern parts of Formosa and on the small island of Hokuto on the west coast. The coal is of Tertiary age and the seams are numerous. Three small seams between 2 and 4 feet in thickness are now being mined. The coal is bituminous and contains about 49 per cent carbon, 40 per cent volatile matter, 3.5 per cent ash and 2.5 per cent. sulphur.

The annual output of the collieries in Formosa is about 350,000 tons per annum. A good deal of development work is being done on the Formosa coalfields, and they promise to be of greater importance in the future.

NAGAMINE OIL FIELD, JAPAN OIL CO., ECHIGO.

Coal of a similar quality to that mined in Formosa occurs in the Loochoo Islands and in Saghalien. Very little mining is done either in the Islands or in Saghalien. The Saghalien deposits are promising but development operations are handicapped by bad transportation facilities and by the rebellious spirit of the people.

Korean Coalfields.

Numerous coal deposits are known to occur in the Mesozoic and Tertiary formations in many parts of Korea. A good class of anthracite is mined near the city of Phyong-Yang.

Bituminous seams have been opened along the railroad near Saruion and Thong-Sin. Lignite and peat deposits have also been discovered. Little attention has hitherto been given to the development of coal mining in Korea, but now that it is a Japanese province it will be actively developed and a demand will be created for local coal.

From this brief survey of the coal resources of Japan, it will be noticed that coal is widely distributed and mined throughout the Empire. The quality of the coal is not so good as the average American or European coal; but it is good enough for most industrial purposes. The collieries are mostly owned by large companies and are worked in a substantial manner. They are equipped with the latest types of American and European machinery and particular care is taken to ventilate the mines and thus prevent explosions and loss of life. In this respect the Japanese coalfields are in advance of the best American fields. The known coalfields in Japan contain sufficient coal to support the Empire for centuries, but care must be taken not to permit the exportation of coal to foreign countries to increase much. The natural resources of the Empire must be strictly conserved if the government's ambitious plans are to succeed.

Silver and Lead.

Silver and lead deposits are found in many localities in Japan, but there are only a few important mines yielding these metals. Their total production is about 4,000,000 ounces of silver and 3,000 tons of lead per annum.

The principal silver and lead mines are the Tsubari, Ikuno, Innai and Kamioka. The Innai and Ikuno mines are the largest producers. The Innai is situated in the Province of Yamagata, on the Main Island. The ore occurs in a quartz vein traversing the intersection of an andesite with a volcanic tuff formation. It is a complex ore calling for skilful metallurgical treatment. It carries gold, silver,

galena, zinc, pyrites, chalcopyrite and a little cinnabar. The mine is extensively developed by shafts, the deepest of which is 1,500 feet. The ore is crushed, classified and concentrated at a mill on the mine and smelted. The annual output is about 12,000 tons of ore yielding 1,000 ounces gold, 95,000 ounces silver and 300 tons of copper per annum. The lead and zinc concentrates are shipped to other smelters.

The Ikuno is an old and famous property. It is situated on a mountain in the Province of Hyogo, on the Main Island, and about midway between the cities of Kobe and Tottori. The ore is found in quartz veins in a formation similar to that of the Innai vein. This ore is also complex, but the various minerals are banded so that it is possible to mine one part of the vein at a time and get the bulk of the copper, lead or silver as desired. When the miners work forward on the copper they work back on the lead-bearing portion of the vein. This saves a lot of trouble and expense in concentration.

There are a large number of shafts on this mine, which is really a series of mines on a single field. The deepest shaft is about 1,000 feet. Lidgerwood hoists are employed for hoisting, Worthington pumps for boiling, and Jager drills in mining.

This mine possesses an extensive crushing, concentrating and smelting plant furnished with American and English machinery. The annual output is about 30,000 tons of ore, yielding 4,000 ounces of gold, 200,000 ounces silver and 1,000 tons of copper per annum.

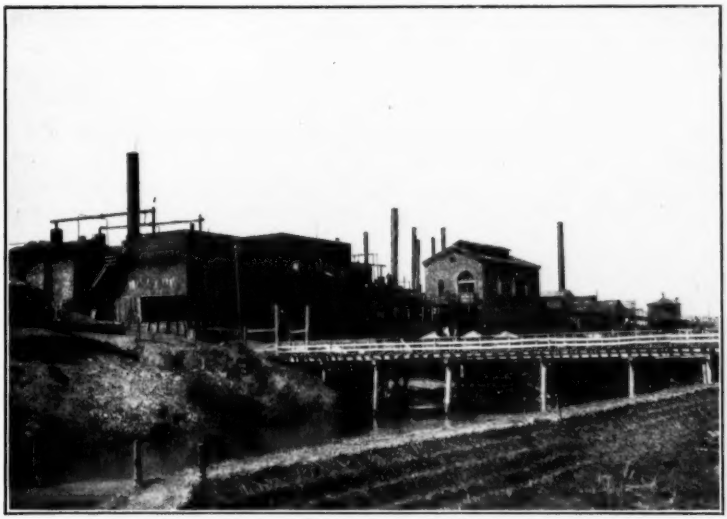
The yearly production of silver in Japan is about 4,000,000 ounces. About 3,000 tons of lead are also produced. This is not sufficient for the needs of the country and between 8,000 and 12,000 tons of lead are annually imported from the United States and Australia. Large quantities of manufactured lead articles like tubes, sheets, and tea-lead are also imported from Great Britain.

Lead occurs in many part of Korea. About fifty years ago several native mines produced the ore, but lately very little lead mining has been done in that country.

Zinc.

Ores containing zinc blende occur throughout the Empire. Many of the richest deposits are unworked on account of the lack of efficient transportation facilities.

The Kamioka mine, situated in the Province of Hida, west of Tokyo, and south of Toyama, is the largest zinc producer at present. The ore is mined from irregular pockets, or lenses, in a limestone formation lying on Archæn gneiss. It consists of a mixture of argentiferous galena, zinc blende, pyrite, and chalcopyrite. The average contents are 5 per cent lead and 12 per cent zinc.



NO. II OIL REFINERY, JAPAN OIL CO., KASHIWAZAKI, ECHICO.

The ore is crushed, jigged and concentrated by hydraulic and magnetic methods. Experiments are being made with some of the flotation processes of concentration that are yielding such satisfactory results on the Broken Hill field in Australia, and it is probable that the metallurgical plant will be renovated and enlarged shortly.

The annual output of this mine is about 90,000 tons of ore, 300 ounces gold, 200,000 ounces silver, 40 tons copper and 10,000 tons of zinc concentrates. It employs 3,000 men.

Zinc deposits occur in Korea, but like the lead deposits, they are unworked at present.

The total production of zinc ore in Japan is about 20,000 tons per annum, valued at $200,000. About 8,000 tons of metallic zinc and zinc bars, sheets, tubes and other manufactured shapes are annually imported by Japan from foreign countries.

Iron.

Numerous iron deposits are known to exist in Japan; but little attention has been given to iron mining. The ores are of various kinds. Deposits of magnetite have been opened up and tested in 27 provinces. Micaceous iron ore is mined in the Akadani mine, situated 32 miles east of the city of Nugata. This mine is owned by the Government and is being developed on an extensive scale. Bog iron ore, hematete, and iron sands are found throughout the islands.

Japan imports about 500,000 tons of iron and steel products, valued at $20,000,000 annually. Its iron mines yield only 200,000 tons of ore and 40,00 tons of pyrites per annum. It appears that the Japanese iron-mining industries have been retarded by lack of capital and competition of European, Indian and American iron smelters. The prices of iron and steel in the Oriental markets have been so low as to deter Japanese capitalists from investing in iron-mining and smelting on a large scale. There are only about half a dozen small iron smelting works in Japan.

Deposits of chromic iron ore occur in four Provinces. All the known deposits are worked in a small way and yield about 2,000 tons of ore yearly.

Antimony, Manganese, and Tin.

These metals are mined with more or less success in several localities. Manganese ores are widely distributed in Japan. Deposits are recorded as having been found in 47 Provinces in Honshu, Shiku and Kyushu, and in two Provinces in Hokkaido. About 2,000 tons of manganese ore are mined annually. The bulk of this ore comes from mines in the Provinces of Shiribeshi, Mutsu, and Tamba.

Antimony ore is mined in the Provinces of Iyo, Suwo, Hyuga and Yamato. The ore is stibnite occurring in Mesozoic formations. The annual production of antimony is about 1,000 tons.

Cassiterite occurs in the Provinces of Satsuma, Hyuga, Tajima, Mino, Hitachi and Osumi. The annual production of tin is only about 30 tons, as compared with from 800 to 1,000 tons imported. The Japanese tin deposits are small and it is probable that, like America and France, Japan must continue to depend upon foreign supplies.

Sulphur.

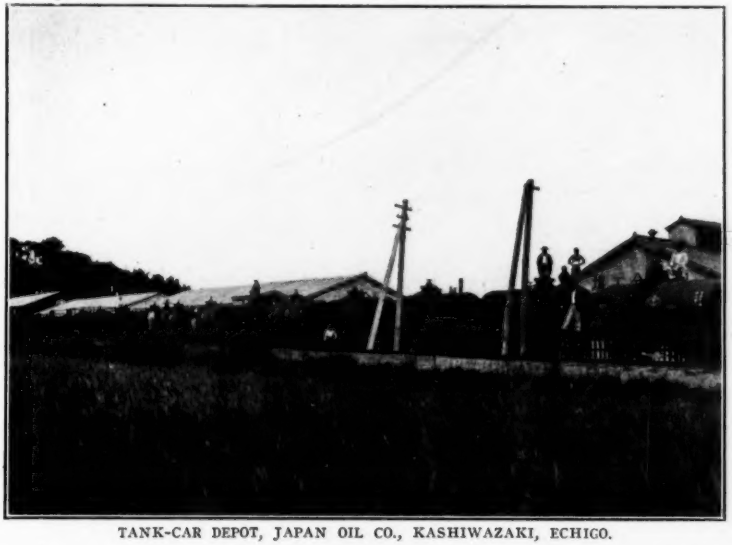
Japan is situated on the line of volcanic activity that encircles the globe and, consequently, the country is frequently subjected to volcanic disturbances. The result is that the Islands contain numerous deposits of sulphur, mercury, lime, salt, petroleum and other mineral substances deposited by volcanic gases and waters.

Sulphur occupies the seventh position in rank of importance among the mineral products of Japan. About 40,000 tons of sulphur, valued at $500,000, are mined annually. Much of this sulphur is exported to China, Canada, the United States, Australia and other countries. It is mined in every part of the Empire from Formosa to Saghalien. The production of the mines is limited simply by the demand.

Petroleum.

Japan is fortunate in possessing numerous oilfields widely distributed. On the inner side of Northern Japan, starting at Kubiki,

in the Province of Niigata, north of the city of Nagano, in the Island of Honshiu, west of Tokyo, a petroleum belt runs north through the Island of Hokkaido to Saghalien. Oil is found also in the Provinces of Mutsu, Ugo, Uzen, Echigo and Shinano. Oilfields are being developed also on the west coast of Formosa.

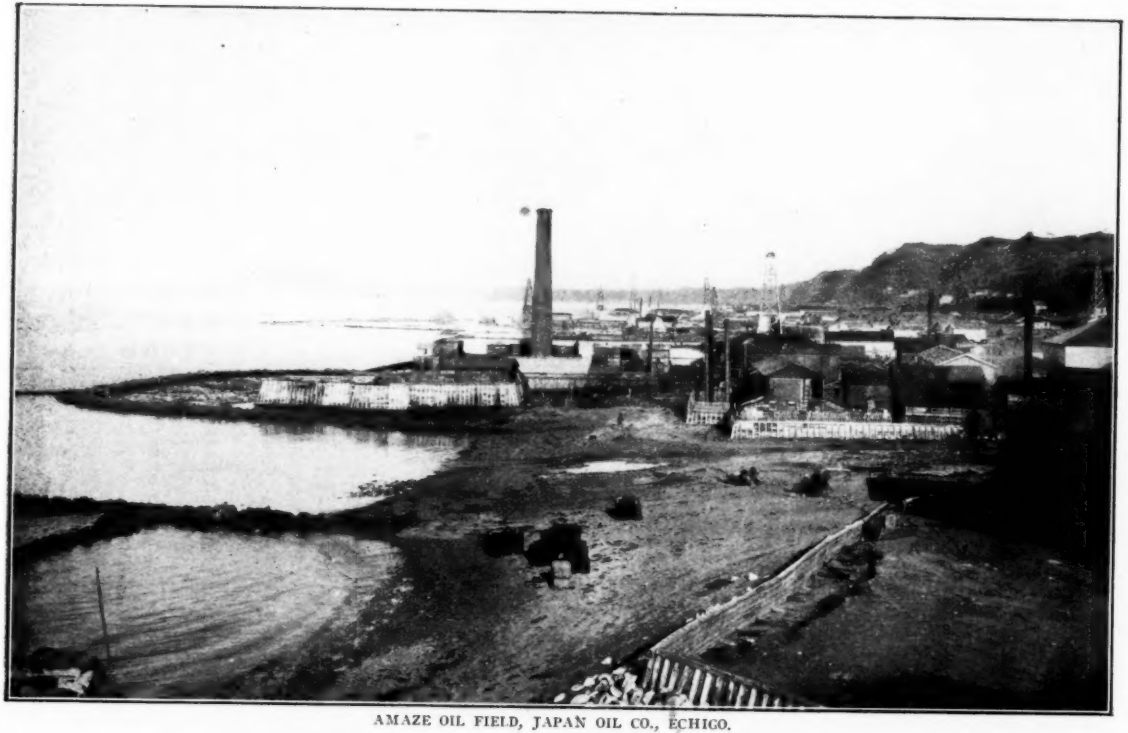


TANK-CAR DEPOT, JAPAN OIL CO., KASHIWAZAKI, ECHIGO.

The oilfields are chiefly monopolized by two large companies—the Japan and Hoden companies. The Nakano and Chuo companies are the principal oil producers after the two large companies. The Japan and Hoden companies produce 86 per cent of the annual output of petroleum, the Nakano and Chuo companies produce about 12 per cent, and numerous small companies produce the balance.

The oil is obtained from wells drilled to depths of from 600 to 3,000 feet by means of American rope drills. Ancient methods of drilling by bamboo poles are now being abandoned. About 2,000 of the producing wells were drilled by American methods, as compared with 300 by the Chinese and 250 by the Japanese methods.

Oil is carried from the wells to refineries by pipe lines. There are twelve important refineries now in operation. These are owned mainly by the Japan and Hoden companies. They produce about 40,000 barrels of benzine, 600,000 barrels of kerosene, 300,000 barrels of light-oil, 600,000 barrels of heavy-oil, 100,000 barrels of machinery oil and 2,000 tons of pitch and wax per annum.



AMAZE OIL FIELD, JAPAN OIL CO., ECHIGO.

The percentage of the petroleum products refined by the Hoden Oil Company is as follows: Kerosene, 43 per cent; heavy oil, 31 per cent; benzine, 7 per cent; pitch and wax, 7 per cent; light oil, 4 to 5 per cent; loss, 5 to 6 per cent.

The petroleum production of Japan in recent years is given in Table III.

TABLE III. PETROLEUM PRODUCTION 1900-8.

Year.	U. S. Barrels.	Year.	U. S. Barrels.
1900.....	871,740	1905.....	1,352,574
1901.....	1,117,995	1906.....	1,571,367
1902.....	997,543	1907.....	1,727,298
1903.....	1,210,340	1908.....	1,872,592
1904.....	1,220,744		

The bulk of the oil is at present obtained from oilfields in the Province of Echigo.

CONCLUSION.

The principal mineral resources of Japan have now been briefly reviewed in this and a previous article. But the list of minerals mined is not exhausted. There are deposits of asphalt, amber, abrasive materials, asbestos, gypsum, steatite, mica, quartz, fluorspar, phosphates, graphite, arsenic, sapphires, topaz, beryl, tourmaline, opal, agate and other valuable mining products worked by miners in the various provinces.

It will be seen that, on the whole, Nature has been kind in endowing Japan with a variety of mineral resources. The Empire's coal, copper, petroleum, antimony, iron, sulphur, zinc, silver and manganese deposits will be sufficient for her requirements for many centuries. Tin, lead, and a few other metals must always be imported from foreign countries.

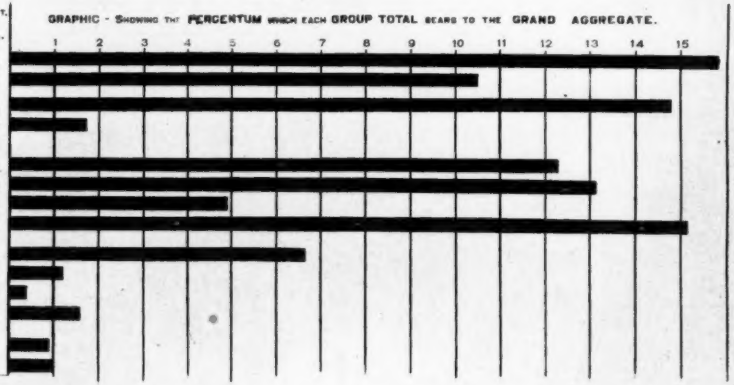
Japanese mines are generally well worked and equipped with machinery. Good and efficient metallurgical works exist for the treatment of metallic ores close to the mines. Japanese engineers have shown a good aptitude for mining and metallurgical work and they have been well backed up by local capitalists. There is every reason for the belief that the remarkable progress made in the development of the Empire's mineral resources during the past decade will be continued, and that this steady improvement will powerfully contribute to the working out of the national ideals of the Japanese people.

THE DEPARTMENT OF FINANCE
WILLIAM A. PRENDERGAST,
COMPTROLLER.

TABLE AND CHART CLASSIFYING ACCORDING TO GENERAL PURPOSE AND SETTING FORTH THE TOTAL AMOUNT OF CORPORATE STOCK ISSUED AND ALLOTTED BY THE CITY OF NEW YORK FROM JANUARY 1, 1898, AUGUST 31, 1910, AND SHOWING THE PERCENTUM WHICH EACH SEPARATE OR GROUP TOTAL BEARS TO THE GRAND AGGREGATE.

GENERAL PURPOSES FOR WHICH BONDS WERE ISSUED.	TOTAL AMOUNT ISSUED AND ALLOTTED.	PER CENT. OF TOTAL.
WATER	$97,067,668	15.80
RAPID TRANSIT	64,450,737	10.50
EDUCATIONAL, VIZ: SCHOOLS	90,924,338	14.80
LIBRARIES	10,570,515	1.73
	$101,494,852 = 16.53%	
BRIDGES	75,245,988	12.24
DOCKS AND FERRIES	80,431,821	13.12
PARKS AND PLACES	30,189,148	4.90
STREETS & ROADS PUBLIC WORKS	93,835,118	15.14
PUBLIC BUILDINGS (OTHER THAN SCHOOLS, LIBRARIES, ETC.	41,273,867	6.72
HEALTH AND STREET CLEANING	7,308,663	1.20
CHARITIES	2,298,490	.37
FIRE-POLICE-CORRECTION	9,510,010	1.59
REFUNDING OLD DEBTS, AND MISCELLANEOUS	5,537,081	.81
DEFICIENCIES IN TAXES	6,000,000	.98
GRAND AGGREGATE OF CORPORATE STOCK	$614,753,630	100%
ASSESSMENT BONDS FOR LOCAL IMPROVEMENTS STREET IMPROVEMENTS	$34,855,532	
GRAND TOTAL CORPORATE STOCK, AND ASSESSMENT BONDS	$649,609,162	

GRAPHIC - SHOWING THE PERCENTUM WHICH EACH GROUP TOTAL BEARS TO THE GRAND AGGREGATE.



GRAPHIC REPRESENTATION OF CORPORATE-STOCK ISSUES, SHOWING THE LARGE PROPORTION DEVOTED TO ENGINEERING WORKS.

AN INFLUENCE FOR EFFICIENCY IN MUNICIPAL ADMINISTRATION.

By Herbert T. Wade.

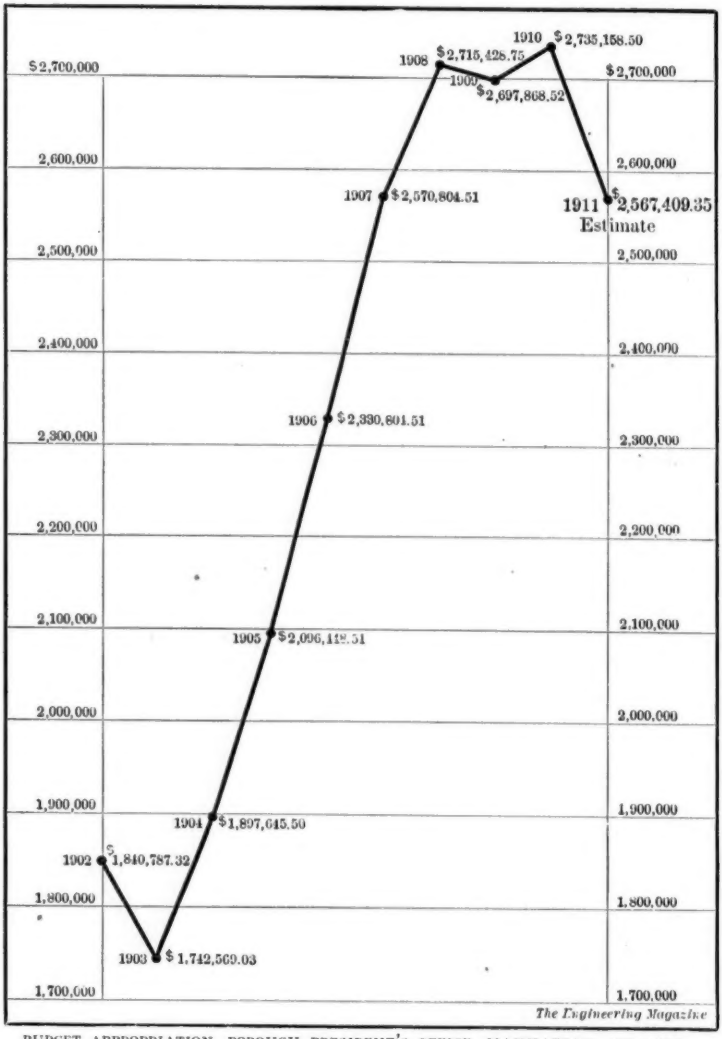
THE NEW YORK BUDGET EXHIBIT OF 1910.

We doubt that the predominance of purely engineering problems in the administration of a large city has ever been so convincingly shown as in the New York Budget Exhibit of 1910. The chart on the opposite page indicates that of the revenues from issues of corporate stock during the last thirteen years, over 70 per cent has been expended on permanent engineering works. Mr. Wade demonstrates in the following pages that the routine of city administration, involving no extraordinary construction or development, calls for engineering ability of a high order, and that the economy and efficiency of municipal government depend, to a large extent, on the placing of competent engineers in the positions of highest administrative authority.—THE EDITORS.

THE Charter of the City of New York provides that each October the Budget of the city's expenses for the following year shall be considered and passed upon by the Board of Estimate and Apportionment and the Board of Aldermen, which make appropriations therefor from the income derived from taxes and other sources. Every city department has the right to explain the purposes for which it desires appropriations, and on the other hand it must be prepared to explain and defend the requests it submits. Such discussions quite naturally involve some consideration of the economy and conduct of the particular department with special reference to values received for public monies expended.

This is a matter that does not concern merely the Mayor and the administration, however keen they may be for a record for efficiency and progress. It is, or at least should be, of vital interest to every citizen, for here he is told the story of his taxes and of the efficiency of the government he has chosen. Therefore what information is supplied to the Mayor and his colleagues in the form of statistics and tables, should be no less useful to the citizen, if it can be put before him simply and in such manner as to stimulate his interest. Once general interest is aroused in this matter an important step towards better municipal administration has been accomplished.

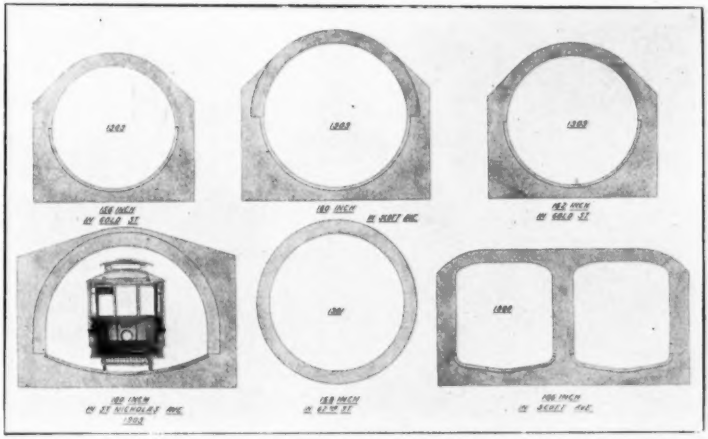
This was the object and the function of such a popular exhibition as was held by the City of New York during the month of October in a vacant mercantile building on Broadway. This so-called "Budget Exhibit" was distinctly educational and attempted to supply the



BUDGET APPROPRIATION, BOROUGH PRESIDENT'S OFFICE, MANHATTAN, 1902-1911.

fullest information in answer to the question, what was being done with the taxpayers' money. Naturally and fittingly it was held at the time when the Budget for the year 1911 was being considered

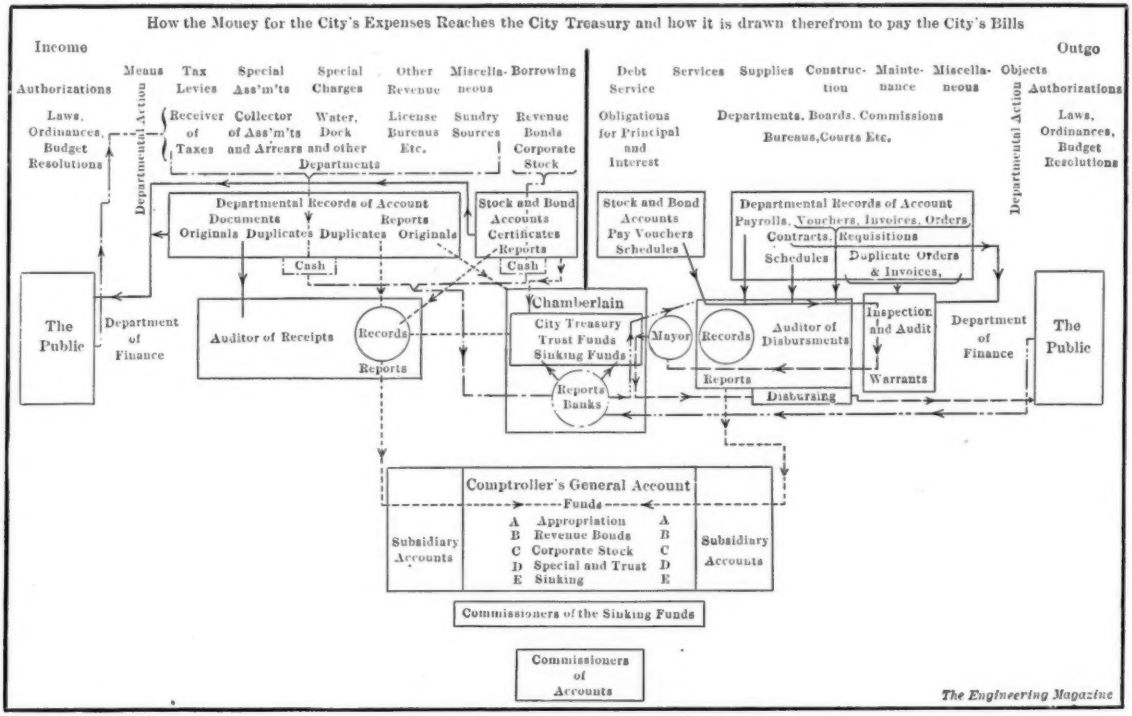
by the Board of Estimate. In fact, such an exhibition fundamentally was but an incident of this work, for all that was asked was that the various departments should show by charts, diagrams, pictorially or otherwise, to what uses the desired appropriations were to be put, the aim being to make the statements simple and easily understood. The Budget Exhibit was not intended, nor must it be considered, as a panacea for municipal maladministration or a direct corrective of inefficiency or corruption actual or alleged. It was a record, one might almost say a picture-book, of the activities of a great corporation in which every citizen should have a live interest, as with a greater or less number of these activities he comes into daily contact.



SOME OF THE LARGE SEWERS OF NEW YORK, A STANDARD TROLLEY CAR DRAWN TO SCALE FURNISHING A COMPARISON.

The inspiration for this exhibition came from attempts made in 1908 and 1909 by the Bureau of Municipal Research to present to the public by charts and diagrams some significant information in connection with the preparation of the annual budgets of those years. These simple displays were termed budget exhibits, and showed the importance of the work of the Bureau, a private agency maintained through the interest of public-spirited citizens to study and investigate matters dealing with municipal administration.

In this effort to arouse interest among the citizens of the great city in their municipal problems a critical attitude was assumed, and the expenses of the city were analyzed in connection with its growth, showing the disproportionate administrative cost to increase of popu-



THE CHANNELS OF THE CITY'S INCOME AND OUTGO.

THE TWO GREAT SOURCES FROM WHICH BUDGET EXPENDITURES ARE PROVIDED

TABLE AND GRAPHIC SHOWING THE TOTAL AMOUNT OF REVENUES PROVIDED BY CURRENT TAX LEVIES AND FROM GENERAL FUND RESPECTIVELY TO MEET THE ANNUAL BUDGET APPROPRIATIONS FROM 1900–1910 AND VARYING YEARLY PER CENTUMS THEREOF

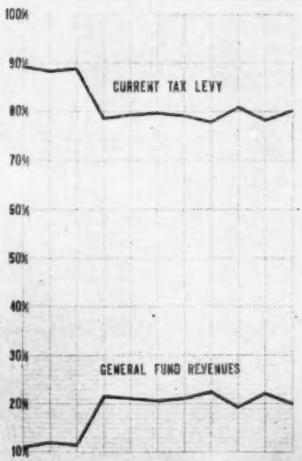
YEAR	BUDGET A	REVENUES TO MEET BUDGET: TAXES A	REVENUES TO MEET BUDGET: GENERAL FUND B	TAX LEVY PER CENT	GENERAL FUND PER CENT
1900	$90.778972.48	80923699.77	9855272.71	89.14	10.86
1901	98.100413.43	86.312.463.55	11787549.88	87.98	12.02
1902	98.619.600.88	87222889.21	11.396.711.67	88.44	11.56
1903	97.119.031.10	76.110.454.87	21008576.23	78.36	21.63
1904	106.674955.09	84.383.361.07	22.291594.02	79.10	20.90
1905	109.817593.03	87240829.19	22576763.84	79.44	20.56
1906	116.805490.37	92.253085.71	24552404.66	78.98	21.02
1907	127.421505.66	98950253.58	28471252.08	77.66	22.34
1908	140572.268.17	113542898.09	27029370.08	80.77	19.23
1909	153622.701.06	119822.763.09	33807537.97	78.00	22.00
1910	159128.270.37	127.478.282.11	31.649.987.26	80.17	19.83

NOTE.—

A

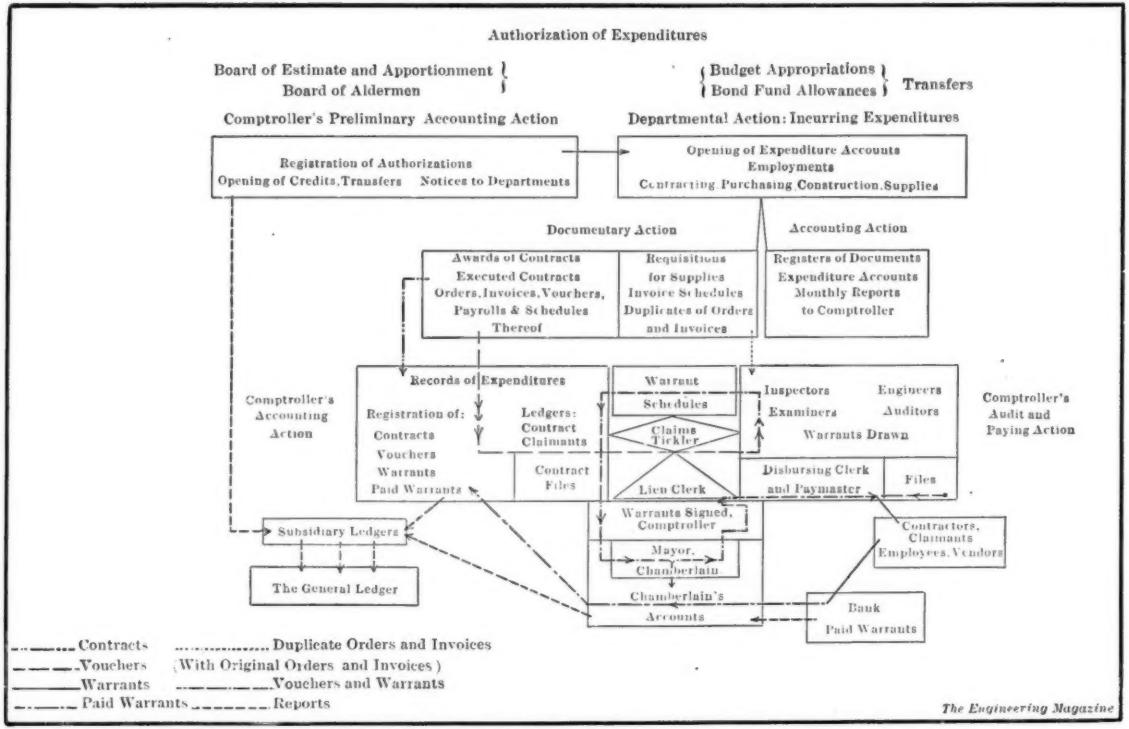
B

COMPARISON OF THE VARYING YEARLY PER CENTUMS OF THE TAX LEVY AND OF THE GENERAL FUND REVENUES TO THE TOTAL YEARLY REVENUE REQUIRED FOR BUDGET APPROPRIATIONS.



lation. Instances were shown where supplies and equipment were purchased by the city and contracts executed at much higher expense or on terms less favorable to the city than would prevail in the case of individuals or private corporations. Good results were accomplished both in arousing public interest in municipal economics and in compelling from the heads of the departments a closer analysis of previous appropriations and of the items in their requests for additional appropriations. As a result for 1910 there was secured a more scientific and businesslike budget, the various departments being called upon to analyze and specify their requests and statements in a manner never before attempted.

The more attention the matter received the more general appreciation there was of the good effects of this publicity and education, and accordingly it was decided by the City authorities to arrange

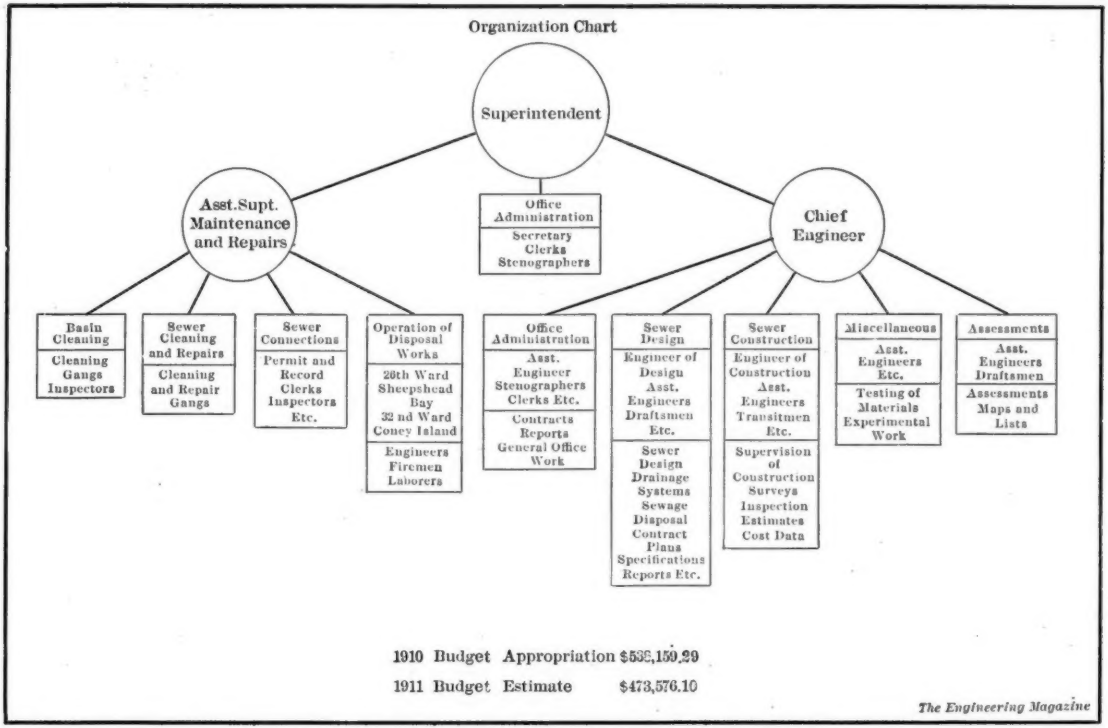


THE CITY HALL OF NEW YORK. MECHANISM OF MUNICIPAL EXPENDITURE AND ITS CONTROL.

such an exhibit in connection with the 1911 budget and to extend its scope. The city departments were informed that they could add to their exhibits prepared for the budget proper, physical objects such as apparatus and equipment, photographs and other material that would afford an interesting illustration of work in the various fields of municipal activity. With no attempt at uniformity or standardization, and in the great majority of cases without the slightest previous experience in arranging objects for exhibition purposes, there was naturally wide diversity of method and this added to the interest of the spectator. Thus in some departments the exhibits were essential spectacular and of direct popular appeal, as the prize-winning and notable horses of the Street Cleaning and Fire Departments stabled in the basement along with the most modern apparatus of these departments. In other cases the statistical charts and diagrams were supplemented by complete collections of photographs, while in others actual work of testing was in progress. Especially interesting were the exhibits of those departments where objects of historical importance or illustrative of types were shown.

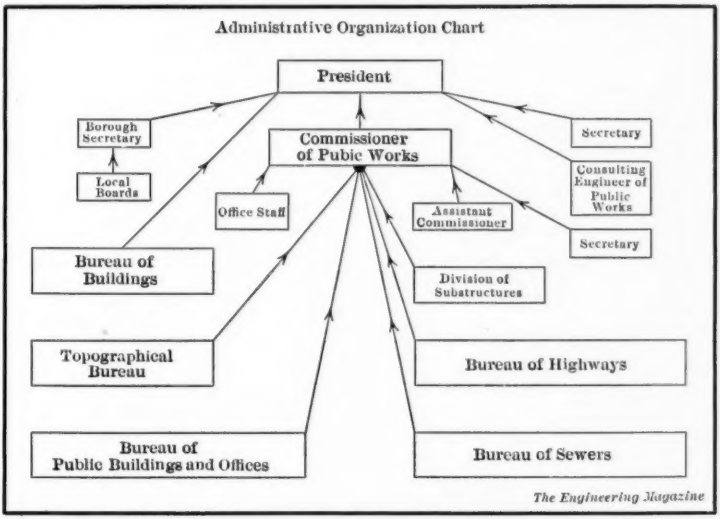
The exhibition, all things considered, was unique and entitled to very serious consideration, both for its immediate and educational value and for the many possibilities it suggested. It demonstrated the important part that systematic and organized economy should play in municipal administration, and emphasized to the general public to what a predominant extent engineering works figure in a great city. In fact, this was indicated so plainly that the conclusion was irresistible that our municipalities today must use in greater numbers the services of engineers and technical men in administrative positions of high authority, not restricting them to subordinate and advisory duties. Indeed, it was pointed out that just as the great railways are using men drawn from their operating and maintenance departments as presidents and vice-presidents and managers, so it will not be long before municipal works must be in the hands of engineers if the highest efficiency and economy are to be secured.

The Budget Exhibit afforded sufficient data to enable one to study the efficiency of the great municipal corporation as a whole and in some detail for a number of the various departments. Thus its work could be compared with that of a private corporation, and in addition one could learn what steps were being taken to provide the additional utilities and facilities needed in the course of future growth and development, or in other words to secure adequate plant and equipment to take care of present and future demands.



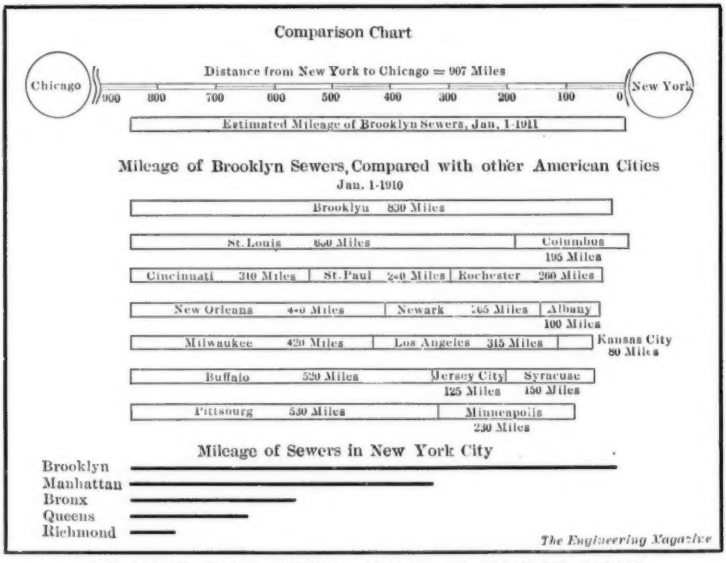
ORGANIZATION CHART OF THE BUREAU OF SEWERS, BROOKLYN.

Any study of municipal efficiency must begin with the organization of the City Government and this was made plain in considerable detail and for all its various branches at the Exhibit by means of graphic charts, a few of which are here reproduced. This city organization is provided for by the Charter, and for better or worse represents the system according to which the City business must be transacted. This of course imposes considerable permanence upon the organization, which unlike a private corporation can not be changed without the amendment of the Charter. So that the first lesson to be learned from the exhibition is the interrelation of the various departments and the accountability of officials and subordinate bureaus, with the precise functions and methods of the latter.



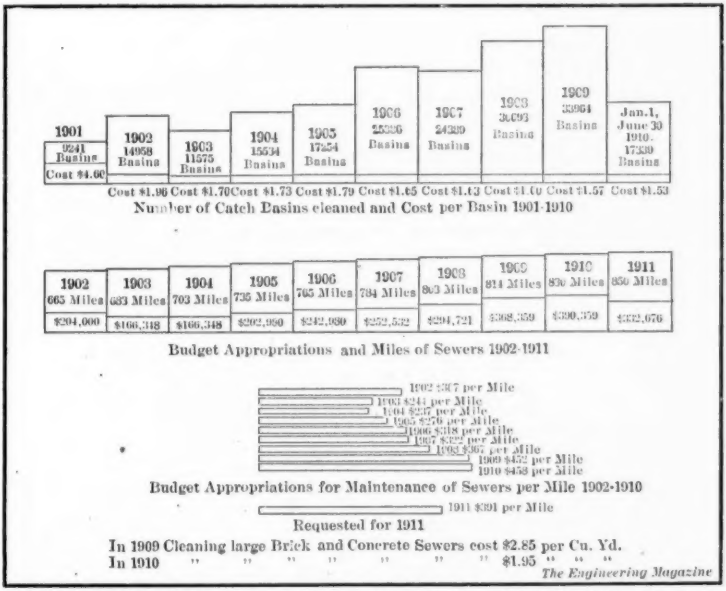
ADMINISTRATIVE ORGANIZATION CHART, BROOKLYN BOROUGH PRESIDENT.

After organization comes the question of resources, or the means to provide for the City's working capital and current expenses. The bonded indebtedness of the City should represent the money expended for permanent improvements which have an earning or perpetual value to the city, as the docks and water supply and the schools, parks and streets. These issues are now known as "corporate stock" and sound city finance demands that such bonds never should be issued for mere maintenance or current expenses, though occasionally this may be unavoidable.



COMPARISON CHART SHOWING MILEAGE OF BROOKLYN SEWERS.

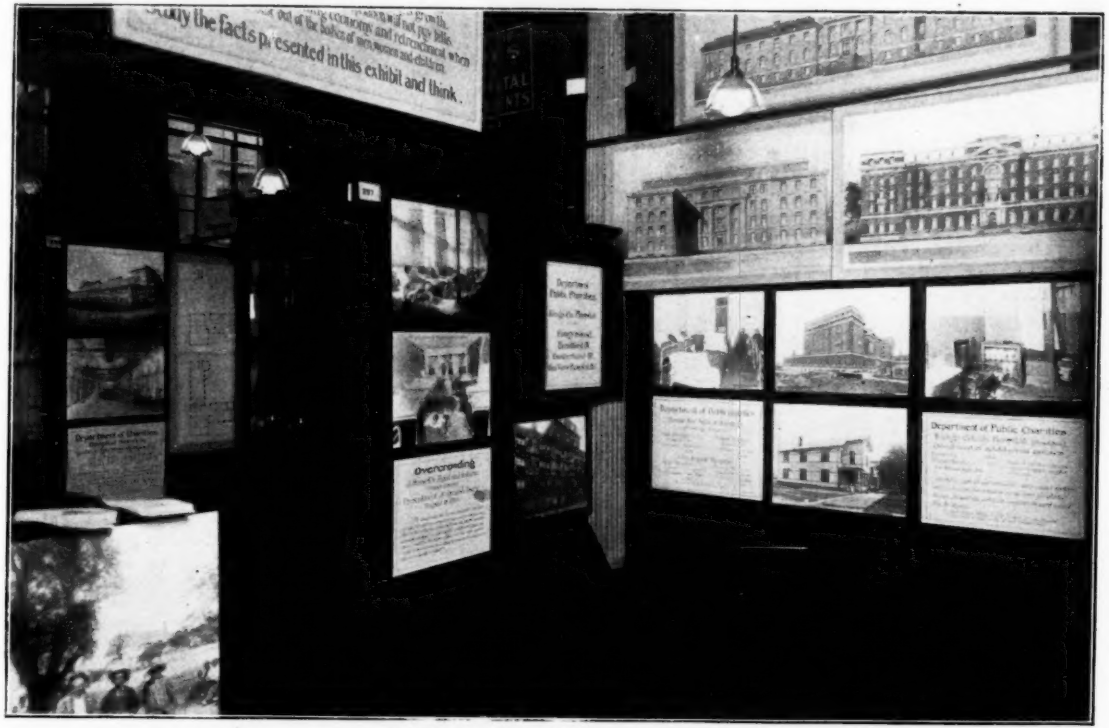
The sources of the City's income are taxes and special accounts such as liquor excise, mortgage and bank taxes, and rentals and payments for franchises, and from this income the appropriations of the Budget are made. The money comes from the public and is expended for the public as was shown graphically on the chart reproduced herewith. It is of course obvious that the taxes in amount must depend upon the amount of the Budget and the tax rate on the assessed valuation. This of course brings up the machinery of assessment and relative valuations which were duly explained by maps and charts. With money thus provided the conduct of the financial side of the City's business and the supervision of its appropriations and expenses falls to the Comptroller and his associates in the Department of Finance. The mechanism and municipal expenditures is arranged as provided by the Charter and by modern methods of accounting, which now are being greatly improved in their application to municipal conditions. As we have seen the large extent to which engineering operations figure in the City's business it can be readily understood that the Finance Department and the Board of Estimate and Apportionment must maintain their engineering staffs. In the former, investigations must be made of the work done by con-


1901 9241 Basins Cost $4.60
1902 14958 Basins Cost $1.96
1903 11575 Basins Cost $1.70
1904 15534 Basins Cost $1.73
1905 17254 Basins Cost $1.79
1906 25336 Basins Cost $1.85
1907 24309 Basins Cost $1.43
1908 30493 Basins Cost $1.10
1909 33964 Basins Cost $1.57
Jan. 1, June 30 1910. 17339 Basins Cost $1.53
Number of Catch Basins cleaned and Cost per Basin 1901-1910
1902 665 Miles $294,000
1903 683 Miles $166,348
1904 703 Miles $166,348
1905 735 Miles $202,960
1906 765 Miles $242,980
1907 784 Miles $252,532
1908 803 Miles $294,721
1909 814 Miles $368,359
1910 836 Miles $390,359
1911 850 Miles $332,676
Budget Appropriations and Miles of Sewers 1902-1911
1902 $367 per Mile
1903 $244 per Mile
1904 $236 per Mile
1905 $276 per Mile
1906 $318 per Mile
1907 $322 per Mile
1908 $367 per Mile
1909 $452 per Mile
1910 $458 per Mile
Budget Appropriations for Maintenance of Sewers per Mile 1902-1910
1911 $391 per Mile
Requested for 1911
In 1909 Cleaning large Brick and Concrete Sewers cost $2.85 per Cu. Yd.
In 1910 " " " " " " $1.95 " " "
The Engineering Magazine

BROOKLYN BUREAU OF SEWERS, MILEAGE AND BUDGET APPROPRIATIONS, 1902-1911.

tractors, and the contracts themselves must be considered in view of engineering questions before they are executed by the representatives of the City. And equally important is the consideration to be given to any proposal for a public franchise by the Board of Estimate, and here the economic side of engineering work is illustrated. Both of these features were brought out prominently by charts in the exhibits of the departments concerned and also the results and expense of such engineering work in some detail.

In almost every department the organization was shown most effectively and it is of course impossible to trace this interesting matter for all of the many branches of the City's activity. A few sample charts will show the methods followed, the aim being to give with the organization the appropriations allotted to the various subdivisions. The charts showing the organization of the office of the Borough President of Brooklyn are reproduced herewith and it will be noted that with the requests for appropriations for 1911 are given those for 1910, amplified in many cases with some record of the work actually accomplished under such appropriations. The work of each of the bureaus of this office is then taken up in greater detail, show-



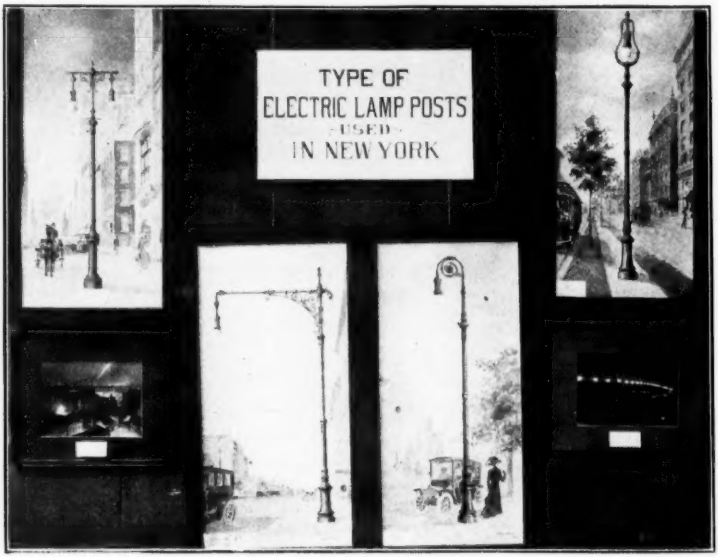
A CORNER IN THE HOSPITAL EXHIBIT.

ing the number of officials and other employees, the amount of work accomplished, and the extent of territory under its care. Then to supplement this were many photographs showing plant and methods as well as the actual performance of the work, while such objects as street signs were also exhibited. In such exhibits the most interesting features were the progress diagrams showing the advance of the city's work in paving, sewer construction, building of baths and markets or similar acitvities. In many cases, and plainly desirable in all, comparative figures were given and the work figured down to a unit cost basis. This appears in the accompanying diagrams of the Bureau of Sewers of the Borough of Brooklyn, and they are both illustrative and typical of many of the different bureaus of the various boroughs or of the city departments.

It was remarked at the exhibition that in subsequent presentations of departmental activities unit costs would figure to a larger extent and would supply valuable data for studies of comparative municipal efficiency, especially as a number of other American cities are contemplating taking up the idea of the budget exhibit and holding similar municipal exhibitions. This was suggested in some of the charts where comparisons were made between the work of some of the single boroughs of New York and other smaller American cities.

An analysis of the various exhibits would mean an analysis of the engineering and maintenance work of the city, a field as fertile when discussed comprehensively as it has been productive in the past along critical lines. While there has been often a wide discrepancy between the design of municipal engineering projects and the economy of their execution, yet steady progress is being made and higher standards of administrative efficiency are shown.

In municipal economy a great defect and often alleged opportunity for corruption has been the purchase of supplies and equipment. Therefore interest attached to reforms in methods of purchasing shown by several of the departments where competitive bids were asked for or other improved methods adopted. Thus the Fire Department exhibited a large number of objects illustrating everyday supplies as well as fire equipment, to each of which was attached a tag stating the price paid, with further explanation in case of a patented article. Prices and qualities were available for inspection by the taxpayer or dealer, so that any criticism of the purchasing bureau could be made if just cause existed. Furthermore the Fire Department made an exhibit of the work of its repair shops, recently reorganized on an efficiency and cost-accounting basis with a considerable



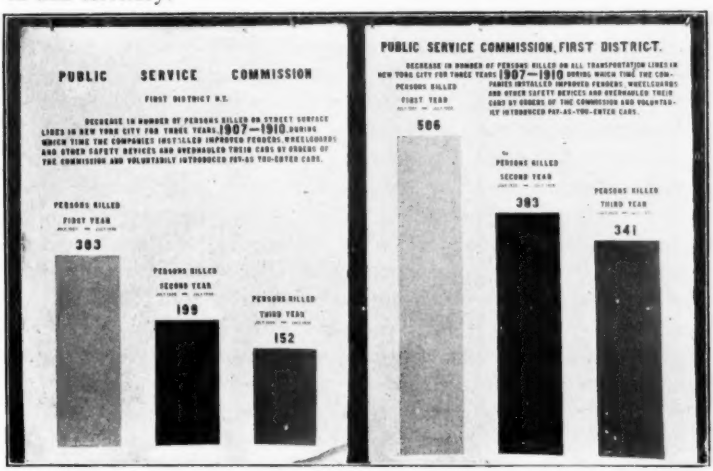
EFFORTS IN MUNICIPAL ESTHETICS.

annual saving to the City and an increase of over 30 per cent in the output, with a reduction of the force from 169 to 150. In 1910 the Bureau of Repairs and Supplies, in which the repair shops are included, while working under an appropriation $81,817 less than for 1909, was able to save $135,000 from the $912,898 appropriated for this purpose.

Here were shown various supplies manufactured in the shops and to each object was attached a cost ticket for the information of any one interested. That there was interest was shown by criticism made of the high cost of a small job from the carpenter's shop. The charge, apparently well founded, led to an investigation and for a small object selected almost at random it was found possible to place the responsibility of its high cost as the various elements of the job were accounted for from the cost record. The explanation was in the labor, which was that of a slow and inefficient workman, protected in his position by Civil-Service rules. This is typical of the tendency towards stricter accountability that is being manifested in most of the city departments and would have been unheard of a quarter of a century ago. But it is exactly such work as is necessary, for from the very nature of their business city shops and bureaus do not lend

themselves readily to efficient operation, concerned usually as they are with emergency work and general repairs rather than manufacturing. It is for that reason that the growth of cost accounting in the municipal machine is as desirable as it is necessary, and successive budget exhibits doubtless will show great progress in this field.

If there is saving for the City in its ordinary work by applying business methods, what can be said of those extraordinary expenditures for well considered improvements that produce an immediate and direct return on the investment. Thus among the lessons to be learned from observing a historical exhibit of fire apparatus culminating with modern automobile machinery was that a year's trial had demonstrated that a motor hose wagon could be maintained at practically the cost of shoeing one of the three horses required for a similar horse-drawn vehicle, and could give better service, so that the citizens were prepared for the announcement that New York was gradually putting its Fire Department on a motor basis. Again as fire houses require no individuality of arrangement or construction, why should there be different plans for each. Accordingly there were shown models of standard type reinforced concrete fire houses for which plans had been evolved and which would be repeated as demanded. Again the high-pressure fire service has eliminated fire engines from the district thus protected, with obvious economy in maintenance, and has caused an important reduction of insurance rates for property in this territory.


PUBLIC SERVICE COMMISSION
FIRST DISTRICT N.Y.
DECREASE IN NUMBER OF PERSONS KILLED ON STREET SURFACE LINES IN NEW YORK CITY FOR THREE YEARS 1907—1910 DURING WHICH TIME THE COMPANIES INSTALLED IMPROVED FENDERS, WHEELGUARDS AND OTHER SAFETY DEVICES AND OVERHAULED THEIR CARS BY ORDERS OF THE COMMISSION AND VOLUNTARILY INTRODUCED PAY-AS-YOU-ENTER CARS.
PERSONS KILLED FIRST YEAR
383
PERSONS KILLED SECOND YEAR
199
PERSONS KILLED THIRD YEAR
152
PUBLIC SERVICE COMMISSION, FIRST DISTRICT.
DECREASE IN NUMBER OF PERSONS KILLED ON ALL TRANSPORTATION LINES IN NEW YORK CITY FOR THREE YEARS 1907—1910 DURING WHICH TIME THE COMPANIES INSTALLED IMPROVED FENDERS, WHEELGUARDS AND OTHER SAFETY DEVICES AND OVERHAULED THEIR CARS BY ORDERS OF THE COMMISSION AND VOLUNTARILY INTRODUCED PAY-AS-YOU-ENTER CARS.
PERSONS KILLED FIRST YEAR
506
PERSONS KILLED SECOND YEAR
393
PERSONS KILLED THIRD YEAR
341

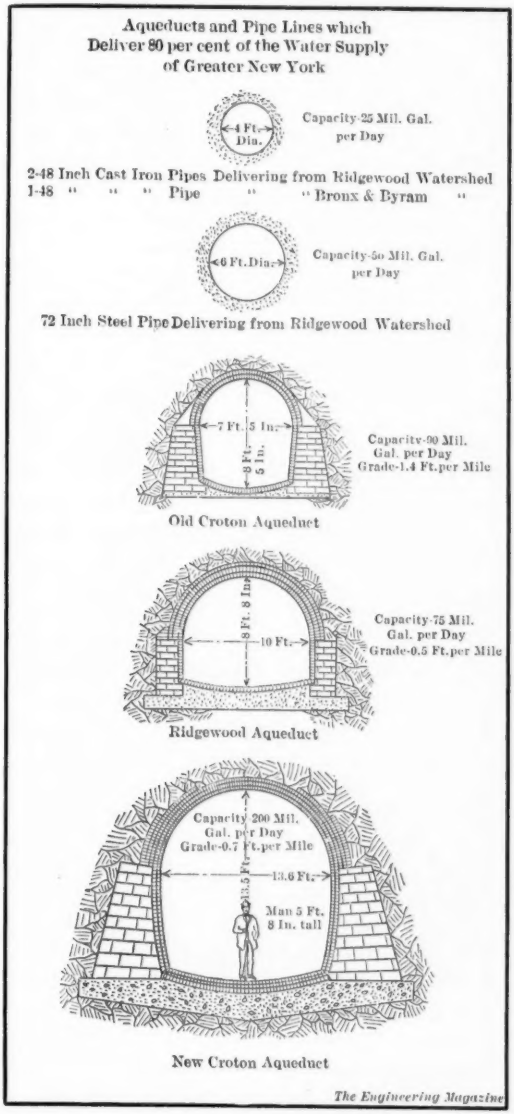
DECREASE IN FATAL STREET-CAR ACCIDENTS FOLLOWING THE USE OF SAFETY DEVICES, ETC.

So much is being done to increase the water supply of New York, more especially the new Catskill Aqueduct in course of construction, involving as it does an estimated outlay of some $160,000,000, that it was but natural that some idea should be given to the citizens of this enormous project. Accordingly there were exhibited models of the important dams, plans and progress diagrams for the tunnels and other works, and numerous photographs to show how this great undertaking is advancing and the conditions under which it is being accomplished. A full sized model showed the cross section of the great aqueduct and typical cross sections of other aqueducts shown in comparison gave some idea of the immensity of an undertaking that can almost rival the construction of the Panama Canal.

If the work of the Water Board involves the source and provision of the water supply of the second city of the world, that of the Department of Water Supply, Gas and Electricity is concerned with its distribution, and the historical objects and charts were striking lessons in the growth of the City. From the wooden pump logs of Aaron Burr's Manhattan Company to the modern high-pressure steel main is indeed a transition, but it was merely typical of other progress. Thus there was represented a fire hydrant, of a type of which many are to be found in the city, so inadequate as to be incapable of supplying a first-size steam fire engine, as contrasted with modern hydrants now being installed on the high-pressure mains with a capacity of three or four steamers. There was also shown the method and apparatus for tapping mains with a minimum waste of water in making a connection with the service pipe of a building, and the methods of metering and detecting leaks. An impressive object lesson was the expense of a leaky faucet as shown by a meter in operation.

Familiar as is the fact to engineers, yet few of the citizens of New York realize that four of the largest bridges in the world connect Manhattan with Long Island and that they exert a most important bearing on the present life and future development of the city apart from any consideration of the engineering elements involved in their construction and maintenance. Today when the subaqueous tunnel figures so prominently in schemes of urban and suburban rapid transit where rivers or tidal water are concerned, the efficiency of the bridge and the traffic it can carry are matters of peculiar interest. It is only fair for the citizen to consider the traffic carried by the bridges, note its diversity, and then figure on the economy.

Furthermore in New York the Bridge Department somewhat anomalously is engaged in building one of the largest and tallest office


Aqueducts and Pipe Lines which
Deliver 80 per cent of the Water Supply
of Greater New York
4 Ft. Dia.
Capacity-25 Mil. Gal. per Day
2-48 Inch Cast Iron Pipes Delivering from Ridgewood Watershed
1-48 " " " Pipe " " Bronx & Byram "
6 Ft. Dia.
Capacity-50 Mil. Gal. per Day
72 Inch Steel Pipe Delivering from Ridgewood Watershed
7 Ft. 5 In.
8 Ft. 5 In.
Capacity-90 Mil. Gal. per Day
Grade-1.4 Ft. per Mile
Old Croton Aqueduct
8 Ft. 8 In.
10 Ft.
Capacity-75 Mil. Gal. per Day
Grade-0.5 Ft. per Mile
Ridgewood Aqueduct
Capacity 200 Mil. Gal. per Day
Grade-0.7 Ft. per Mile
13.6 Ft.
13.5 Ft.
Man 5 Ft. 8 In. tall
New Croton Aqueduct
The Engineering Magazine

AQUEDUCTS AND PIPE LINES DELIVERING 80 PER CENT OF THE WATER SUPPLY OF GREATER NEW YORK.

buildings in the City to house many of the City offices as well as provide a terminal for the subway trains crossing to Brooklyn. Here is a very simple example of municipal finance. The terminal is demanded, so the ground must be secured. Therefore it is possible by an outlay of $11,100,000 to build an office building large enough to house many of the departments for which offices are being rented in private buildings at an annual expense estimated at over $600,000. As the interest on the bonds issued for the erection of such a building would amount only to about $450,000, the saving to the City both in money and convenience is most apparent, while the erection

of a fine monumental structure serves to beautify the official centre of the City.

In practically every department of the City the work of the engineer and architect is encountered at least in providing the necessary buildings and plant, even if their services are not demanded for the operation. This is shown in the departments of Education, Health, and the various corrective and charitable institutions, of which Bellevue and Allied Hospitals may be taken as typical for the interesting exhibit that they made of their work and equipment, accompanied by requests for additional appropriations in order to extend it further. Such exhibits assembled together brought directly to public attention what previously has not always been realized, that municipal betterments, necessary as they may seem to the philanthropist and the specially interested reformer, can not be executed without expense, and that each problem, while it may appear to such persons most vital, is but one phase of a larger one. In the case of hospitals, schools, reform and penal institutions, parks, etc., it is of course plain that with better equipment and increased facilities and plant far better and more valuable work could be done, but such appropriations would at once react on the tax-rate, increasing rents and living expenses so that the advantage might be questionable in many cases and negative in not a few. Therefore the present problem for city administrative officers is to secure under present conditions maximum efficiency and economy and see that the various institutions are brought up to their fullest possibilities, making of course due and judicious provision for the future. These considerations were emphasized at the Budget Exhibit by the splendid exhibits made by all of these institutions.

Wherever it was possible to show anything in action from a census tabulating machine to a fire alarm the opportunity was seized upon, and the citizen of New York for once at least had the opportunity to become conversant with the City government and its operation. Every department was represented and in addition to exhibits lectures were given daily in a small auditorium by representative officials, while a series of booklets describing the duties of the various bureaus and departments was prepared and distributed to supplement the exhibition proper. In fact, so much interest was aroused that in many quarters was heard a demand for a permanent municipal museum as a record of the City's history and activity on its administrative and material side. The large attendance demonstrated that civic interest and pride were more than latent and that there was a genuine desire to learn about the resources and methods of the city government.

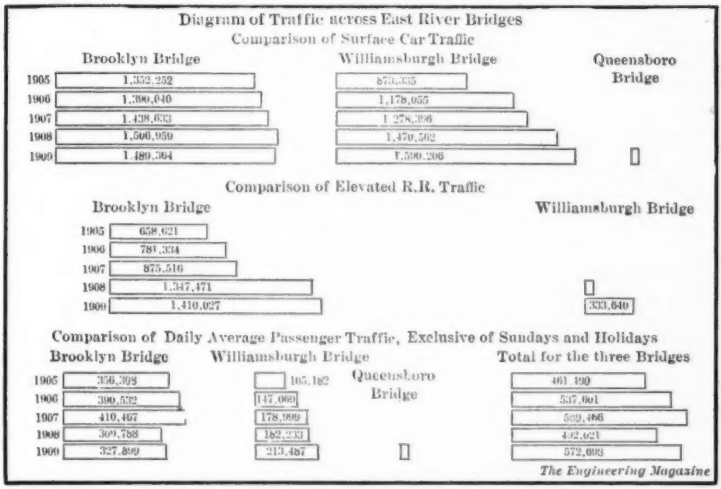


DIAGRAM OF TRAFFIC ACROSS THE EAST RIVER BRIDGES.

As a picture of the city's condition and activity it was strong, direct and forcible, and so obvious were its benefits and merits that there was included in the Budget for 1911 $25,000 appropriation for a similar exhibition in connection with the Budget for 1912. In future exhibits it should be possible to secure such a standardization of presentation that the main facts in the City's economy could be presented from year to year systematically and an intelligent basis of comparison between different administrations as regards their efficiency could be made. This would put the matter still further outside of any spirit of mere partisan criticism and enable it to be considered as a business or efficiency proposition. In fact, with the political or at best semi-political government of American cities, partisan criticism has accomplished little save temporary improvement of conditions, and not always that. Lack of appreciation of efficiency and honesty in effort and achievement has been all too common in municipal work and is responsible for many of our present ills. But give the citizen with his growing interest in municipal efficiency the facts simply and succinctly stated and he will decide and decide rightly for good government. No administration or municipal party could afford to go before the voters for endorsement if its mayor or commissioners or other officials were shown to be less efficient than their predecessors.

That such progress would be increased by a permanent museum of municipal government seems evident, and a permanent record of the growth and development of the City would be of untold value. Such a museum would not only be replete with historic interest but would readily become a museum of standards where public exhibition could be made of the standard articles used by the City in its various departments, the exact specifications for their purchase and the method of test. This would be especially desirable in the event of the establishment of a central purchasing bureau for the entire city, but in any event it would permit public inspection and criticism of standards and prices so that at any time a superior article or one more economical could be brought to the attention of the city officials.

The history of a municipality unlike that of a state or nation is told largely by its monuments of stone and mortar, by its structures of iron and steel, made by its engineers and architects rather than by the lives of its soldiers and statesmen. The individuality of the authors of these massive works too often is sunk, but the works themselves remain as monuments of efficiency of government and sound engineering. For they are only possible where the money of the taxpayer is well conserved and wisely expended, and must be constructed in permanent and useful form productive of direct returns to the city. Politics and administrations may vary but water supply and facilities for commerce and the general well-being of the citizens are always needed, and these must progress according to some definite and prearranged plan. Now if the administration of justice, the preservation of the public peace, the alleviation of sickness and poverty, the prevention of fire, the preservation of the public health is not done effectively, little remains either of spirit or resource to make possible the permanent improvements that reflect so much credit on a city and add to the wealth and happiness of its citizens. In city government the connection between the material and the ideal must be ever present and is not to be discouraged, for growth in one is only possible through development in the other. The Budget Exhibit teaches that what is accomplished or needed on the material side of the city can be done only by the observance of principles of economy and efficiency. Once educate the citizen as to the methods of the municipal housekeeping and he will be ever watchful to demand efficiency in order to secure the greatest benefits in his daily life. Even among those who have graduated from practical politics into municipal administration it is now admitted that a record for efficiency and economy must be considered a paramount consideration.

EDITORIAL COMMENT

Scientific Management.

THROUGH attention attracted by the recent rate hearings at Washington, efficiency has taken rank as a National issue. Or, rather, its importance to continuation and progress of national welfare has gained wider recognition. The truth—always vital—is no greater than before, but acknowledgment of the truth is fuller. The recent awakening among manufacturers is remarkable. Eventually, even if reluctantly, the railways must follow.

It is not surprising that in the minds of old-line managers the suggestion of a new viewpoint from which to consider the whole problem of production should cause bewilderment. It is not surprising that they should seize upon the one element that has a familiar sound—piece rates—and leap angrily to the utterly false conclusion that scientific management is "a kind of piece work." It is even less surprising that the editors of daily and general periodicals should stumble and blunder over the purpose and scope of efficiency effort, and should confound it with mere physical driving at a faster rate.

It is, however, astonishing and deplorable that an engineering journal, which claims to lead educated thought, should sum up the question as it affects the efficiency of railway operation in the following syllogism: (1) Efficiency methods can not be applied to household servants; (2) running a railway is like keeping house; (3) therefore, efficiency engineering, or scientific management, can not be applied to railway operation.

In point of fact, the principles of efficiency engineering can be, have been, and are, most successfully applied to the management of the household and its servants. As the major premiss of this curious argument is untrue, it is unnecessary to consider the dignity or accuracy of the minor premiss. The conclusion falls without further attack.

It may be of interest, however, to follow one step further the editorial of which this syllogism is the central thought, because this next step is characteristic of the ill-informed concept of efficiency above referred to. The editorial goes on to suppose that a country railway station agent could be taught by "efficiency experts" "to sell tickets with one hand, while he made out freight way bills with the other"; nevertheless, there would be no gain because "the railway must have a whole man at each station and could not get along with 5/16 or 27/32 of a man"; so, it concludes, "there is no place that we can see where any saving could result in the railway payroll."

The vision of this writer is limited apparently to perspiration as a measure of efficiency. And yet a little observation of the work of a country station agent would suggest various ways in which, by elimination of wastes, prevention of losses, the acceptance of a larger view as to his functions and as to efficiency in performing them, with expert suggestion how best to accomplish this result, the agent might be stimulated to the very great advantage of the operation of the road, without any ambidextrous gymnastics or any strain on his muscular system.

He could save minutes in the movement of passenger trains by having his baggage on the trucks close to where the baggage car would stop, his people on the platform near to the coach steps, and attention to other details of his passenger business. He could save hours for the local freight, to say nothing of the saving to consignees, by the arrangement of his freight house and attention to his outgoing shipments, his way bills and records. He could save days in the

detention of freight cars on his siding, by a combination of diplomacy and hustle in handling local shippers; he could be a good or a bad business agent for his road, and exercise a material influence on its earnings, even at a non-competitive point.

It is interesting to see that the editorial reaches the conclusion that "the great difficulty with railway operations at present is that the men in charge are so overburdened with routine matters that they have as a rule no time or energy to spare for new means or methods of saving over those which have been long in use." The very genius of efficiency engineering or scientific management is that it places functional betterments in the hands of a separate staff, leaving the line officials free for routine administration. It lightens the burdens of the operating men, instead of adding something more to them.

Educational or Administrative Efficiency?

A STUDY of the efficiency of education is professedly difficult, and Mr. Morris Llewellyn Cooke's report on academic and industrial efficiency, made to the Carnegie Foundation, is prefaced by a full acknowledgment of this difficulty. He recognizes clearly the difference between the work defined by the instructions given him, and a final estimate of either absolute or relative efficiency measured by intellectual and moral effect upon the university student. It is somewhat hasty, therefore, to leap, as many commentators do, to the conclusion that Mr. Cooke's studies are a complete demonstration of great inefficiency in American universities, with perhaps some slight lift above the prevailing low level in the case of Columbia and Toronto.

So far as the use of funds, buildings, equipment, and personnel go, the most casual inspection would demonstrate that, judged by common industrial standards, our universities are wastefully administered. But the real energy of a university is mental and spiritual, and spiritual force is not measurable in any terms recognized in Mr. Cooke's instructions. He was limited to "an estimate of the cost and of the output both in teaching and in research in the departments of physics" in eight institutions. Even adopting so mechanical a concept of university "output," efficiency is determined largely by the balance and co-ordination of many departments. The method of inspecting a "sample" department is utterly inadequate.

So far as concerns the observations possible to a careful and intelligent inspector, the obtaining of material statistics, and deductions based on the discriminating use of principles of industrial efficiency, Mr. Cooke's report is admirable. He formulates conclusions in terms of student hours, room hours per week, and other unit data, permitting both absolute and relative measures of work to be made on this basis. The conspicuous lack both in Mr. Cooke's conclusions and in Dr. Pritchett's instructions, is the lack of realization of, or attempt to estimate, a factor that formerly at least was considered one of the prime influences, if not the foremost influence in university work—the influence of character and personality of great men. Let us qualify this by hastening to add that Mr. Cooke does recognize most fully the importance of allowing the professor the largest opportunity to express his individuality and his personal influence, by relieving him of conflicting duties in the same way that a high-priced industrial officer would be relieved. Nevertheless, his relative estimates, in certain specific cases, reverse the order of precedence in which these certain universities would stand if measured by their known success or failure in enlisting and keeping great men. The most important factor in the greatness of a university is the most subtle.

HUMPHREY PUMPS AND COMPRESSORS.

A REVIEW OF A YEAR'S PROGRESS IN THE IMPROVEMENT OF OLD AND THE DEVELOPMENT OF NEW DESIGNS.

Herbert A. Humphrey—Manchester Association of Engineers.

IT is just a year since the first paper by Herbert A. Humphrey descriptive of his gas pump and its application to air compression was reviewed in these columns. Our review of this paper, which was read before the Institution of Mechanical Engineers, was limited to a consideration of the possibilities of the system in the compression of air and in power production, and was intended merely to supplement an account in THE ENGINEERING MAGAZINE for December, 1909, of the principles and design of the gas pump and the results of Prof. Unwin's tests on the original unit. During the year the system has been developed with unexpected rapidity and has shown a remarkable flexibility. Pumps of the suction-lift type have been designed without the objectionable change-over valves incorporated in the first models. A simple device has been produced for automatically maintaining constant volume of the explosive charge, in spite of variations in the level of the supply water. The space occupied by a pump of a given size has been reduced; the 1,000 horsepower unit now under construction in Germany will compare favorably as to space occupied with a tandem double-acting gas engine of the same power. In short, no case has been presented in which the system has not proved elastic enough to meet the conditions.

A detailed review of the year's developments has been given by Mr. Humphrey in a recent paper before the Manchester Association of Engineers, printed in *Engineering* for November 18, 1910. So far, Mr. Humphrey confesses, the solutions of some of the problems presented to him exist only in designs, but in view of the simplicity and reliability of the pumps so far tested, he has no doubt that the new proposals will mature into efficient and commercialy successful machines. It is the purpose of this brief abstract of his paper to review a few of the most striking of the new designs.

The Humphrey system may be briefly described as "a method of raising or forcing liquid, which consists in applying the energy of expansion of an ignited combustible mixture to one end of a column of liquid so as to propel the column along a discharge pipe, and to cause it to oscillate in the pipe under such conditions of energy of the moving liquid that everything necessary for preparing for the next ignition is performed during one or more oscillations, and wholly or partly owing to it or them." Figure 1 shows the pump in its simplest form. Water is to be raised from a supply tank *ST* to an elevated tank *ET*. *C* is the combustion chamber, *W* the water valve box with valves *V* opening inwards, and *D* the discharge pipe. *A* and *E* are, respectively, inlet

and exhaust valves connected by a simple interlocking gear. The cycle of operations is as follows: A charge of gas and air compressed in the top of *C* with all the valves closed is fired by a sparking plug in the top casing. The pressure of the expanding gases sets the whole column of water in *D* in motion,

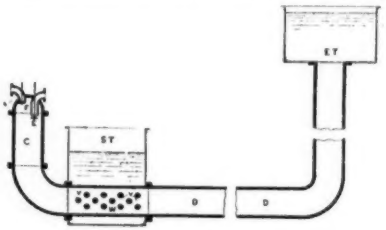


FIG. 1.

and this water attains a momentum so great that it continues to flow after the pressure of the gases has been reduced to that of the atmosphere. At this point the exhaust valve *E* opens by its own weight, and water is admitted through the valves *V*, mostly to follow the moving column in *D*, but partly to rise in chamber *C* in an effort to reach the level of the water surface in *ST*. When the water column has expended its kinetic energy, it flows back towards the pump, gaining velocity until it reaches the exhaust valve *E*, which it closes by impact. The energy of the moving column is expended in compressing the burnt gases imprisoned in the cushion space *F* to a pressure greater than that due to the static head in *ET*. The water moves outward a second time; when it reaches the level of the valve *E* the pressure in *F* is again atmospheric. Further movement of the water opens valve *A* against a light spring and draws in a fresh charge of gas and air. Once more the column of water returns under the elevated tank pressure and compresses the charge of gas and air, which is then ignited to start a fresh cycle of operations. The action of the pump is not altered if, instead of delivering into an elevated tank, it discharges into an air vessel or into an open standpipe or tower. This is the type of pump which was shown in operation at the Brussels Exposition, and which obtained the highest possible awards both in the gas-engine class and in the pump class. The valve mechanism of this pump Mr. Humphrey describes in detail.

The fact that in the Humphrey pump the burnt gases are so well cooled at the end of the long expansion stroke that they will not ignite an incoming combustible charge makes it possible to have a true two-cycle pump. Figures 2a and 2b show alternative arrangements of the top of the combustion chamber for a two-cycle pump. The combustion chamber has to be specially shaped so that the incoming charge, which may be preceded by pure air, displaces the burnt products and mixes as little as possible with them. In Figure 2a, *A* is the admission valve at the top of a tall but narrow part of the chamber *B*, in which the full charge volume extends down to the level *c c*. A number of exhaust valves *E* lead to a common exhaust outlet *O*, which may be fitted with a non-return valve, or each exhaust valve may carry a light non-return valve on its spindle, as shown. The level at which expansion reaches atmospheric pressure is, say *f f*, but this level having been

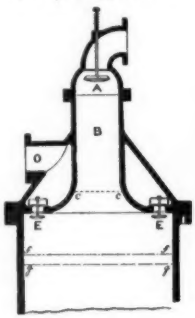


FIG. 2a.

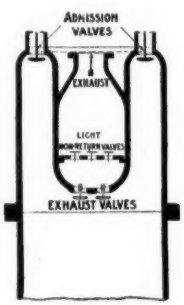


FIG. 2b.

reached by the water its further movement draws in fresh combustible mixture till it occupies a space down to *c c*, and the liquid level has fallen to *g g*. The column of liquid now returns and drives the exhaust products through the valves *E* (which opened by their own weight) until these valves are shut by the water. The kinetic energy acquired by the column is now spent in compress-

ing the fresh charge, which is ignited to start a new cycle. Thus each out stroke is a working stroke, and no locking gear is required on the valves. The same cycle applies to Figure 2b, but in this case there are a number of admission valves placed in a ring so as to allow the mixture to enter with a low velocity, in order to prevent eddies and mixing with the exhaust products. The advantage of the cycle is that a higher compression pressure is obtained than with the simple pump, and consequently higher efficiencies with the same lift.

Figure 3 illustrates the double-barrel pump, the cycle of which may be readily surmised. Explosion occurs alternately in the two combustion chambers *A* and *B*, and in each chamber there is the usual cycle of compression, explosion, exhaust, and the taking in of a new charge, thus again involving four strokes of unequal length. In this case, the water column has only one outward and one inward movement per cycle, but the expression "two-stroke" could be applied only to the water column, and not to what occurs in the combustion chambers.

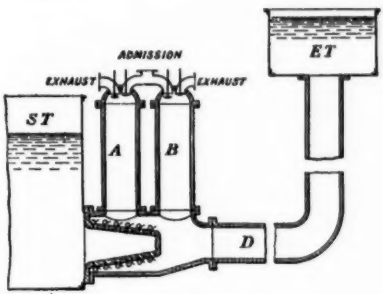


FIG. 3.

The action of this pump differs from that of the simple pump first described in that the new charge is taken in merely by water falling under the action of gravity, and does not depend upon the compression and expansion of an elastic cushion; hence the clearance spaces at the tops of the combustion chambers may be reduced to the very small volume needed to bring easily to rest that portion only of the column which rises in the chamber, the main body of the column being brought to rest by the compression of the new charge. The advantages of the two-barrel over the simplest of the single-barrel pumps are three: higher explosion pressure for the same water lift, due to the increased purity of the charge caused by the decrease in clearance space and to the higher compression pressure; increase of the number of cycles possible in unit time; and greater output for a given total weight of pump and play pipe.

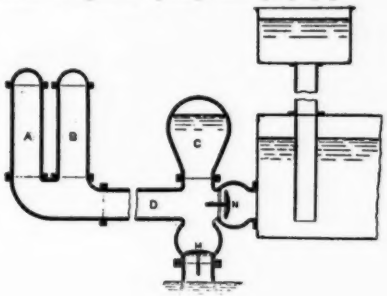


FIG. 4.

Five types of single- and double-barrel suction-lift pumps are described by Mr. Humphrey, one of which is illustrated in Figure 4. On explosion in *A* the water column moves outwardly from the chambers and compresses the air in *C* until the pressure is sufficient to lift valve *N* and pass water into the high-level tank. On the column coming to rest, valve *N* shuts and the compressed air in *C* expands again, imparting velocity to the column, and enabling the expansion to pass below atmosphere, and so lift water from the low-level tank at the same time that exhaust in *A* and compression of the new charge in *B* take place. The cycle is then repeated.

Coming now to high-lift pumps, any Humphrey pump, whether single or double barrel, may be converted into a high-lift pump by means of an air vessel fitted with valves and called an "intensifier." The idea is first to allow the water column to gain velocity and then to utilize its kinetic energy to compress an elastic fluid and to deliver water under the pressure to which the elastic fluid has been compresed. Figure 5 will

make the cycle clear. At the end of the play pipe *D* of a two-barrel pump are two air vessels *E* and *F*, the latter large enough to give a continuous flow at outlet *O*, and to maintain a practically uniform pressure. *E* is fitted with a pipe *K*, open to the atmosphere at the top and carrying a valve *L* at its lower extremity arranged to close under the action of the rising water. The cycle starts with explosion, all valves except *L* being shut and the water level as shown. The column of water rising in *E* gains speed until valve *L* is shut by impact. The air in *E* is then compressed until its pressure is sufficient to cause the high-pressure water valves *W* to open. Water is now forced into *F* until the column comes to rest, when the valves *W* close. The return flow, caused by the expansion of the compressed air in *E*, exhausts *A* and compresses a fresh charge in *B* to start a fresh cycle. Valve *L* opens when the water level falls below it and air is admitted into *E* for the rest of the return stroke.

If the pipe *K* is made vertically adjustable with regard to *E*, any desired quantity of air can be entrapped in *E*. Since the degree of compression is maintained constant by the pressure in *F*, the amount of energy stored in this air will vary directly with the quantity. Hence, the ratio of the total energy of the working stroke to the energy stored in the compressed air in *E* can be made anything desired, or, in other words, we can obtain any desired pressure of the new charge in *B* entirely independent of the water lift. By manipulating the position of valve *K* a given pump can thus be made to meet any conditions as to height of lift.

An important development of this arrangement is made by connecting *K* to a supply of combustible mixture instead of allowing free opening into the atmosphere. *E* then becomes an automatic pump for taking in mixture and discharging it under pressure. If the discharge is into a reservoir from which combustion chambers *A* and *B* can be supplied, we have at once a means of quickening the cycles and greatly increasing the output of an apparatus of a given size. The 1,000 horse-power pump now under construction in Germany will operate on this principle.

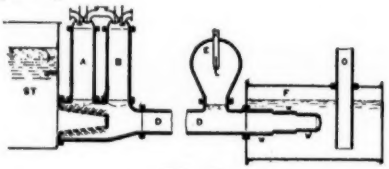


FIG. 5.

If the column of water oscillating in the play pipe of a Humphrey pump is used as a water piston, and caused to rise and fall in an air vessel fitted with suitable valves for the inlet and outlet of air, the combination constitutes an air compressor of a very efficient type and of the greatest possible flexibility. As mentioned above, the operation of the Humphrey compressor has already been described in these columns. We must refer our readers for details to the review in our issue for January, 1910, or to Mr. Humphrey's paper. We may say in passing, however, that all the conditions of output, up to the full limit of the compressor, may be governed at will, and for all ranges the compression pressure of the new charge may be kept up to the required degree, so that the apparatus works at its maximum efficiency throughout its whole range.

With regard to the efficiency of the Humphrey pump, with a compression pressure of eleven atmospheres absolute, the theoretical thermal efficiency of the cycle is 52.5 per cent, whereas that of the Otto cycle is only 40 per cent when all corrections for varying specific heats are allowed for. Such compression pressures have not yet been adopted, but they will be employed in the 1,000 horse-power pump already referred to. In the meantime, when using only very moderate compression pressures of under 50 pounds per square inch, an actual thermal efficiency of over 23 per cent has been obtained on a four-cycle Humphrey pump. This corresponds to 0.95 pounds of anthracite per hydraulic horse-power hour, and was obtained on a lift of only 35 feet. There is every reason to believe that when the com-

pression pressure reaches that employed in ordinary gas engines, the best efficiencies attained in gas engines will be reached and probably surpassed by the Humphrey pump.

In concluding his paper, Mr. Humphrey discusses briefly the application of the Humphrey pump for the purposes of marine propulsion. The theoretical efficiency of the jet propeller is well known and admitted. The trouble has been to find a pump which would be at once pump and engine combined, and which would handle large quantities of water so that the area of the jet at the point of exit might be comparable with the area of the water acted upon by an ordinary screw propeller. Mr. Humphrey believes that his pump fulfils the required conditions, and he offers a diagram showing one possible arrangement.

STREET LIGHTING WITH TUNGSTEN LAMPS.

DATA OF THE SAVINGS EFFECTED BY THE SUBSTITUTION OF TUNGSTEN LAMPS FOR INCANDESCENT GAS LAMPS IN THE BOROUGH OF ST. MARYLEBONE, LONDON.

Haydn T. Harrison—Institution of Electrical Engineers.

A TEST of the economy of the tungsten lamp in street illumination has been made on a large scale by the Borough of St. Marylebone, London, which recently replaced nearly two thousand gas lamps with pairs of 35-watt and 55-watt Osram lamps. Full data of the installation and of the savings effected are given in a long paper by Haydn T. Harrison, read late last November before the Institution of Electrical Engineers. Mr. Harrison dealt comprehensively with the subject of modern street illumination by electricity, and his data were not confined exclusively to the St. Marylebone installation nor to incandescent lamps. The abstract following, however, which is taken from *The Engineer* for December 2, 1910, is limited to a consideration of the savings effected by the tungsten lamps at St. Marylebone.

In order to ascertain the illumination given by the gas lamps, an outside testing authority, intimately connected with the gas industry, was instructed to test at random 100 street gas lamps in the district. The results showed an average for the single 4½ cubic feet mantles of 50 candlepower and 76.6 for the double mantles. The author also carried out a similar test, and with the single mantles he obtained an average of 45 candlepower and with the double 76 candlepower. It was decided that the single lamps should be replaced by two 115-volt 35-watt Osram lamps in series, and the double lamps by two 55-watt lamps. The existing gas lamp-posts being the property of the Council, and having been maintained in good condition, it was decided to retain them. The light from the tungsten lamps having a profile curve favourable to street lighting, it was only necessary to accentuate this by means of reflectors.

On the other hand, the use of something which would counteract the effect of high intrinsic brilliancy of the light source on the iris of the eyes was considered desirable, and a properly designed so-called reflector was, therefore, adopted. It was estimated that the capital cost of converting 1,964 lanterns and connecting them to existing distributors would be £8,000, but it is stated that the work was actually done for £5,788, or an average of less than £3 per post. The work was completed in three months, which represents an average of nearly 200 posts a week. The excellent results obtained have led the Council to decide to convert the remaining 1,385 lanterns in the district, but, owing to these not being adjacent to existing distributors, new ducts and mains were necessary.

As these would eventually have to be laid for private lighting and power supply, it is difficult to allot the right amount of capital charges to the public lighting, but the author states, even if the whole of this were allotted to public lighting

based on a twenty-five year loan, and the cost of the electric fittings be repaid in three years, £1,640 would still be available for electric supply, if the existing gas rate were still charged for lighting. This is equivalent to .9d. per unit for the first three years, and 1.17d. per unit thereafter. The 1,964 lamps, when lighted by gas, cost the Council for gas, lighting, extinguishing, cleaning, and maintenance, £8,818 per annum. The gas contractors, when asked for a revised tender, reduced their price considerably, but were unable to compete with the tenders of the electricity department, which amounted to £7,350 per annum, made up approximately as follows:—

	£.	Per post. £. s. d.
A. Electrical energy at 1.42d. per unit	3,950	2 0 0
B. Lighting, extinguishing, cleaning, painting, etc.	1,570	0 16 0
C. Lamp renewals	1,230	0 12 6
D. Repayment of cost of electric light fittings in three years.	600	0 6 6
Total	7,350	3 15 0

It should be remembered that 1,964 street lanterns included in this charge contain lamps of various candle-powers, as shown by the following table:—

	Measured at 20 degrees.	Candle-power at 10 degrees.
335 two 80-watt lamps	135	220
491 two 55-watt lamps	75	130
1,138 two 35-watt lamps	55	100

The proportionate cost of each lamp per annum is approximately as follows when taking energy at 1.42d. per unit:—

	70-watt. s. d.	110-watt. s. d.	160-watt. s. d.
A	28 6	45 0	64 0
B	16 0	16 0	16 0
C	12 0	12 0	15 0
D	6 6	6 6	6 6
Total	63 0	79 6	101 6

In the above figures the price charged per unit is 1.42d. This figure was not arrived at with any idea of the cost to the electricity department, but in order to repay the cost of the services at an early date. It will be noted that if the charge per unit had been 1d., which is more consistent with the cost of generating, the sum of £3,950 per annum would be reduced to £2,780, which allows £1,170 per annum for repayment of cost of services, etc., the cost of the repayment of the fittings being already allowed for. This will easily wipe off the cost of the services in five years.

The author points out that, as a consumer, a street lamp is very attractive, the load factor is good, no expensive meters or other apparatus are necessary, and it is not likely to have to be cut off owing to termination of tenancy or vagaries of that description. By the introduction of these metallic-filament lamps in Marylebone a saving of £1,500 a year has been made in the lighting rate, and at the same time the illumination of the streets has been improved. The 1,964 gas lamps gave a total of 109,000 candle-power, and the 1,964 electric lamps gave a total of 146,000 candle-power at 20 degrees, and 193,883 at 10 degrees. The illumination has naturally been increased directly in proportion to the increase of candle-power, as the position, height, etc., of the lamps remained the same.

Whilst discussing highly illuminated streets and the use of high candle-power units of light the author makes reference to the use of high-pressure gas lamps, and draws attention to some tests which were carried out by Mr. J. Morris, from which the latter gentleman draws the conclusion that the high candle-power of a high-pressure gas lamp varies 50 per cent., depending on the quality and pressure of the gas. His figures show that from 30 to 34 candle-power per cubic foot of gas consumed per hour is a very average result when working at a pressure of 4 inches of mercury. As the author's own figures tend to corroborate this, he takes as an example a 1,500 candle-power Keith lamp, which gave on test between 720 and 780 candle-power with a consumption of 23 cubic feet per hour. This, compared with a flame arc lamp giving 5 candle-power per watt at 1d. per unit, would have to be supplied with gas at 7d. per 1,000 cubic feet in order to produce the same light for equal cost, and the author therefore points out that even high-pressure gas lamps do not compare favourably in cost, which embody the improvements of the last few years.

Among other interesting points which the author touches upon is the use of open type arc lamps and tungsten lamps.

He states that two districts bordering on Marylebone are lighted by the former, in each of which nearly 1,000 of these lamps were erected, and are still in use. In one of these districts, where they are spread over nearly 25 miles of streets, the cost per mile of lighting is about £880, the minimum illumination resulting in this case being .05 candle feet. Reference to the Marylebone figures, where the same class of street is illuminated by means of the tungsten lamps, shows that with a minimum illumination of .08 candle feet nearly half as much again is obtained at a cost of £414 per mile, or less than half. In the other neighboring district the arc lamps are spread over nearly 37 miles of streets, and are arranged to give two different degrees of minimum illumination, namely, in the important thoroughfares .012 candle feet and .008 in the other thoroughfares. At the prices charged this works out at about £450 and £350 per mile respectively. Comparing this with Marylebone, where the illumination even of the side streets is more than double the first degree and sometimes even triple the first degree, the cost does not exceed £204 per mile.

MAGNETIC ALLOYS FROM NON-MAGNETIC MATERIALS.

AN INVESTIGATION OF TERNARY ALLOYS OF COPPER AND MANGANESE WITH ALUMINIUM, TIN, ANTIMONY AND BISMUTH.

Alexander D. Ross—Institute of Metals.

ON the basis of their magnetic properties, metallic elements are commonly divided into two classes—"magnetic" and "non-magnetic." In the first class are placed iron, nickel and cobalt, the three simple metals which exhibit in a marked degree the phenomena of magnetic attraction and repulsion and of permanent or residual magnetism. While the other elements are placed in the "non-magnetic" class, many of them are not strictly non-magnetic. Under the action of powerful magnetizing forces they exhibit polarity, although the magnetism induced in them is relatively very small and generally vanishes with the removal of the magnetizing force. Such metals are more accurately described as "para-magnetic" than as "non-magnetic," and the special term "ferro-magnetic" has been introduced to denominate materials highly magnetic and retentive.

Within recent years the study of the magnetic properties of alloys of two or more elementary metals has had important commercial results. It has been found, for example, that chrome and tungsten steels possess great retentivity, and are especially suited to the manufacture of permanent magnets. Further, the addition of silicon or aluminium to iron produces, in certain cases, a material of high susceptibility to magnetization and of low hysteresis loss, particularly valuable in the manufacture of transformers. Of still greater importance, from the theoretical point of view, was the discovery that by alloying together the two ferro-magnetic elements nickel and iron in the proportion of one to three, a non-magnetic material is produced. The reverse phenomenon, the production of a decidedly ferro-magnetic material by the alloying of non-magnetic or para-magnetic elements, was unknown until 1903, when Heusler announced his discovery that certain binary and ternary manganese alloys show considerable ferro-magnetism. Alloys of manganese with aluminium, arsenic, boron, bismuth, antimony, and tin were found to possess magnetic properties, which they retain when copper is added, the ternary alloy in some cases being more strongly magnetic than the binary material. The most remarkable of these ternary alloys are those of the copper-aluminium-manganese group, commonly referred to as the Heusler alloys, which have been widely studied. Certain members of this group have a saturation intensity of magnetization equal to about 80 per cent. of that of pure nickel; in low fields they are as permeable as cast iron.

Little attention has been given to the ternary alloys of copper and manganese outside the aluminium group. The first record of tests on any considerable scale is contained in a paper read by Alexander D. Ross before the Institute of Metals last September, which is reprinted in *Engineering* for November 4, 1910. Prof. Ross' investigation, which has been in progress since 1905, has comprised a detailed examination of the properties of one of the most highly magnetic of the copper-manganese-aluminium group—in particular, of the effects produced by varying thermal treatment; an investigation of other members of the same group, and of ternary alloys of copper and manganese with tin, antimony, and bismuth; and fianally an investigation of binary alloys of copper with manganese and aluminium, and of manganese with antimony and boron, for the elucidation of the more complex phenomena of the ternary alloys.

The materials used in the preparation of the alloys were of the highest possible degree of purity. In the preparation of the ternary alloys, the plan adopted was to make first a copper-manganese alloy (usually in the proportion by weight of seven to three) and then to add the third metal to it. The test bars were cylindrical rods, 9 inches long and 7/16 inch in diameter, cast vertically in dry sand moulds. The binary alloys, being too feebly magnetic to test by the usual methods, were cast as small rods measuring 4½ inches long and ¼ inch in diameter. The bars were in all cases made sufficiently long to permit the rejection of a small piece from the lower end, and also the cutting of two samples for chemical analysis, one from either end.

The apparatus used in the tests comprised a special type of magnetometer designed by Dr. J. G. Gray and Prof. Ross, an electric furnace for use within the magnetizing solenoid, and a platinum and platinum-iridium thermo-couple. The programme of the tests was as follows: (1) To determine the magnetic quality of the alloys in the condition as cast; (2) to find the simplest and most efficient heat treatment for bringing the alloys into a stable condition with the highest possible magnetic quality; (3) to investigate the changes produced in the magnetic properties by exposure of the alloys to different temperatures, and incidentally to determine the critical temperature and investigate the reversibility of the thermal treatment; and (4) to examine the effects produced by quenching, annealing, and baking the alloys.

The alloys to which reference will be made had the following percentage compositions:—

	Percentage composition.			
Alloy.	Cu.	Mn.	Al.	Sn.
1.....	75.5	16	8	....
2.....	62	25	12.5	....
3.....	54	30	15	....
4.....	60.2	25.1	....	14.1
5.....	58.7	23.5	....	16.1
6.....	57.6	24.9	....	18
7.....	49.2	20.4	....	29.8
8.....	43.4	18.1	....	40
9.....	36.4	15	....	48.1

Alloys 2 and 8 were the most strongly magnetic in their respective classes, and the results of tests on these two alloys will be used as a standard of comparison in what follows.

The alloys were first tested as cast, without any preliminary dressing operations save only the removal of the end portions, at room temperature (15 degrees C.), and at the temperature of liquid air (—190 degrees C.). The results of the tests on alloys 2 and 8 were as follows:—

	Intensity of Magnetization.			
Applied field, H.	Alloy 2. 15 deg.	n 190 deg.	Alloy 8. 15 deg.	n 190 deg.
20.....	254	300	21	21
50.....	292	358	53	53
100.....	310	388	95	95
200.....	324	401	159	160
Residual....	85	160	11	11

While the effect of cooling to the temperature of liquid air is large in the case of aluminium alloy 2, and practically imperceptible in the case of tin alloy 8, the effect varies greatly in different members of the same series. The percentages of improvement in intensity of magnetization corresponding to a value of H of 100 for alloys 1 to 9 are, respectively, 20, 25, —1, 21, 26, 35, 1, 0, and 0. The general improvement in intensity is a characteristic feature of these alloys; most of the magnetic materials, such as iron, steel, iron alloys, nickel, and cobalt, are in general less susceptible to

magnetization at low than at normal temperatures.

The majority of these bronzes are improved in quality by exposure for some time to temperatures between 150 degrees and 200 degrees C. Usually the improvement has a double origin—the removal of initial stresses, and a constitutional change into a new equilibrium condition, and in most cases it can be effected in two steps, corresponding to the two distinct processes involved. When the internal strains are removed by heating to, say, 180 degrees C. and cooling slowly, the alloy is merely "normalized," without any change in its initial magnetic properties save a slight increase in intensity which is uniform throughout the magnetization curve. Heating the alloy for several hours at a temperature of 180 degrees C. before the slow cooling to room temperature produces a constitutional change in the material, which is altered from a metastable condition towards the true equilibrium condition corresponding to temperatures not far from room temperatures. In the case of the aluminium alloys, normalizing has little effect, but a considerable increase in the saturation value of I (amounting in the case of alloy 2 to 10 per cent. without increase in hysteresis) can be obtained in some instances by annealing at 170 degrees C. for six to eight hours. In the case of the tin alloys, on the other hand, normalizing often produces a decided improvement, while annealing or baking results in an increased hysteresis loss more than counterbalancing any slight improvement in susceptibility.

After quenching at high temperatures, the aluminium alloys are always less magnetic, but the coercive force, and consequently the hysteresis, are greatly diminished. Coercive force varies greatly in different materials: in very soft iron it is 1.7 C. G. S. units, and in quenched tungsten steel 50 units. The coercive force of alloy 2 is reduced from 1.3 units to less than 0.3 units by quenching at 550 degrees C. By quenching at 400 degrees C. the coercive force of alloy 8 is reduced from 9 units to 6 units. If the quenched aluminium alloys are left at room temperature for several months they gradually recover their magnetic quality and finally attain a permeability little less than that which they had previous to the quenching, with no appreciable increase in the small value of the coercive force. Alloy 2 treated in this way has fair permeability and extremely little hysteresis loss, and is at least an approximation towards the ideal magnetic substance.

The quenching phenomena of the tin alloys are more complex. Quenching at temperatures high above the critical temperature renders the material almost non-magnetic, but at moderate temperatures the alloys are almost as magnetic as before quenching. An interesting point in regard to the quenched alloys of both groups is that they are nearly all more sensitive to temperature variations than they were in the unquenched condition. We have given above for alloys 1 to 9 the percentages of improvement in intensity of magnetization corresponding to a value of H of 100 when the alloys are cooled from 15 degrees C. to —190 degrees C. The corresponding values for the same alloys when quenched are 400, 33, 50, 25, 33, 35, 5, 9, and 5.

Tests of the magnetic properties of the cast or normalized alloys at successively increasing temperatures until the critical point was attained and at successively decreasing temperatures from the critical point to room temperature have demonstrated that the magnetization of the tin alloys is reversible, while that of the aluminium alloys is not reversible. The latter are much less magnetic at each definite temperature during the cooling process than they were at the same points during the heating. The critical temperatures of the tin alloys range from 220 degrees C. to 280 degrees C., while those of the aluminium alloys are, respectively, 280 degrees, 500 degrees, and 345 degrees C.

Copper-manganese-antimony alloys have properties very similar to those of the aluminium alloys. The bismuth bronzes, however, differ from the others in that quenching at 300 degrees C. makes the materials much more magnetic (in one case the increase was over

60 per cent.), increases the retentivity of the alloys and increases also the coercive force.

Tests of the binary alloys show that copper-manganese containing about 30 per cent. of manganese is more retentive after quenching than in the cast condition, in which it differs essentially from the aluminium and tin ternary alloys. On the other hand, an alloy containing about 10 per cent. aluminium and 90 per cent. copper exhibits the improvement on cooling to the temperature of liquid air and the deterioration on quenching characteristic of the ternary aluminium alloys. This 10 per cent. aluminium bronze differed from all the others tested in that it contained the intermetallic compound Cu_3Al. As alloys approximating in composition to this formula are apparently the most magnetic of the aluminium-copper series, Prof. Ross suggests that this compound plays an important part in the magnetism of the copper-manganese-aluminium bronzes. The magnetic properties are due, he says, to the formation of solid solutions, of which the comopund Cu_3Al is a constituent. Mn_3Al is known to be the most magnetic of the manganese-aluminium alloys. It is possible then that a series of solid solutions occur between the compounds Cu_3Al and Mn_3Al, and give rise to the ferro-magnetism of the ternary alloys. Owing to the difficulties of testing, however, one cannot be certain as to whether the solid solutions are formed merely between Cu_3Al and Mn_3Al, or whether uncombined manganese enters into them. Prof. Ross has undertaken a metallographic investigation to clear up this point. As to the magnetic properties of the copper-manganese-tin alloys, Prof. Ross believes them to be explicable on a similar theory of the formation of solid solutions.

THE TRAINING OF YOUNG ENGINEERS.

PRACTICAL SUGGESTIONS OF VALUE TO MANUFACTURERS AND EMPLOYERS, AS WELL AS ENGINEERING GRADUATES.

Melville W. Mix—The Purdue Exponent.

WE have heard much in recent years of the remarkable advance that Germany has achieved, through her technical and manual training schools, in the preparation of young men for both industrial and commercial callings. But this deserved commendation of educational methods has seemed to leave out of account the very rapid advance which American manufacturers have been making, not alone in the adoption of scientific methods of management and operation, but especially in the employment and practical training of young men who have graduated from technical schools and colleges. And in no field is this advance made more evident than in the multiplication, enlargement, and very great improvement of the technical schools and colleges of the United States.

A notable instance of this is shown at Purdue University, Lafayette, Indiana. Beginning in 1880, former Dean W. F. M. Goss established an engineering school in a little basement in one of the University structures. This modest experiment found such immediate popular approval that first one, then a second, and finally a third new building was erected for the necessary accommodation of the rapidly-growing classes. Now it has been found that an entire new group of buildings is necessary to accommodate the Department of Practical Mechanics, and provide facilities for instruction in mechanical drawing, descriptive geometry and shop work. The main building contains 25,000 square feet of floor space; can accommodate at one time 400 students in drawing, and has locker accommodations for 1,200 students. The shops cover 43,000 square feet of ground and are capable of accommodating a group of 350 students at one time. The machines, tools, benches, lockers, in fact, all the details of the equipment are modern, while many of the special features are unique. The

buildings as a whole constitute what is probably the largest and most completely equipped plant for the instruction of students in shop practice and drawing in America and represent the accumulated experience of twenty-five years at this university. To teach manufacturing in the broader sense, rather than manual training, is the object ultimately sought in the construction and use of these buildings.

This special group of buildings was completed during the past summer, and the dedication exercises were held in November. Mr. Melville W. Mix, President of the Dodge Manufacturing Co., Mishawaka, and also President of the Manufacturers' Bureau of Indiana (numbering 1,000 members and representing all the leading industries of the State), was the principal speaker upon that occasion; and in the course of his address he offered practical suggestions of so much value to manufacturers and employers, as well as engineering graduates, that we take pleasure in reproducing here the main portion of his address.

Speaking first from the standpoint of a manufacturer and employer, Mr. Mix said: "No better evidence of the high esteem in which Purdue University is held by the manufacturers of Indiana need be stated at this time than to call attention to the large number of graduates of this institution which are now employed by manufacturing and mining companies, municipalities, public utilities and transportation corporations of this State. I do not believe there is an important institution of any of these divisions of engineering that has not one or more Purdue engineers occupying important positions. One needs only to look over the transactions of the Indiana Engineering Society to receive further proof of the high places occupied by Purdue graduates. And 'there is a reason.' The training here has been thorough and practical, and I marvel at the results that have been attained with the former meagre equipment. When Purdue men leave this place they are fitted to 'do things.'

"I mentioned to Dean Benjamin the other day when he was up to Mishawaka, that it seemed easy to get large sums appropriated for agricultural development, but that the engineering section seemed to have a hard time with the Legislature, and asked the reason. He said it was a very simple matter—that the farmers were so well organized through their various granges that he could get the support of 30,000 farmers inside of 24 hours. Now that we know how it is done, I am glad to assure you of an organization of manufacturers—the Manufacturers' Bureau of Indiana—that has a membership of nearly 1,000, representing every manufacturing district of the State. That will also be reachable in 24 hours, or quicker if necessary. We were only half as effective at the last session as you wanted us to be, but we shall hope to secure a more liberal appropriation next time if you can show correspondingly good results.

"Indiana demands substantial recognition in this field because of the great development in manufacturing that is taking place in this State. It may be well to call your attention to the fact that the American center of manufacturing, as well as of population, is in Indiana. No more strategic position is occupied by any State than is enjoyed by Indiana when it comes to assembling materials, cheap power and high-class labor, by means of which we may produce a wide range of manufactured articles and distribute them economically to all of the principal markets of this continent and of the world.

"Then, there is another reason why we should build and maintain the greatest technical university in America—we need the men in our business; they are our home boys and we have the opportunities open for them. All we ask is that they take advantage of these openings by absorbing all you can teach them here; then let them get into the real game. There is no more interesting game in the world than manufacturing. The greatest opportunities are afforded for the development of any talent the young man may possess. The manufacturers don't have much trouble getting men for positions but they do have trouble in making them stick and become masters of

their work. They nearly all want to be general superintendents, consulting and supervising engineers, and attach a lot of other high sounding titles to their names as soon as they have learned how to ring in on the shop clock.

"The dirt and noise of the mill is distasteful to many who would otherwise make good; but I want to tell you boys, that is where 'we need the goods.' Don't be in too big a hurry to put on a stiff collar and have a stenographer and a string of push buttons. Most of the success of to-day has been earned from the bench and glare of the furnace. The association of men in their daily work is a most important factor; it serves to knock the frills off many a good chap, and brings him to the point of respecting a horny palm and an honest, industrious heart wherever it is found. And, generally, he is the fellow who knows his business from stem to stern. He has had his apprenticeship in the College of Hard Knocks—an institution that knows no favor, and you will want to know him better.

"This institution is a fitting climax to the educational prowess of Indiana. Industrial education is the thing today—beginning in the kindergarten, then through manual training, and later through shop apprenticeships to the colleges and engineering laboratories, until we find it the most important feature of our national development.

"I shall hope that it may be a part of your educational plan to extend the feature of specialization—perhaps in a way of post-graduate courses. It is essential that industrial engineers be educated in cost-keeping, production, engineering, sales promotion, piece and premium work, and other labor problems. It is to be hoped that special chairs may be provided for teaching these collateral subjects to industrial engineering, for therein lies the greatest function that such an organization as this can perform."

THE FIELD FOR GRINDING.

A DISCUSSION OF THE ECONOMY OF GRINDING IN CERTAIN CLASSES OF WORK, IN COMPARISON WITH THE REMOVAL OF METAL BY TURNING OR MILLING.

C. H. Norton—American Society of Mechanical Engineers.

GRINDING processes and grinding machines were the subject of three papers read at the annual meeting of the American Society of Mechanical Engineers last month, and discusses in a special session of the Machine-Shop Section. The topic was introduced by a paper by C. H. Norton on the field for grinding, which is abstracted at some length below. We reserve the papers by W. A. Viall, on precision grinding, and B. M. W. Hanson, on modern grinding methods, for subsequent consideration.

Mr. Norton first shows the fallacy of the common idea of grinding as a slow, tedious, and laborious process. "The fact about grinding with the modern grinding machine and grinding wheel (not emery wheel)," he says, "is that it enables us to size all round work cheaper than by turning and filing, that it takes the place of what we formerly called the finish cut of the lathe and all filing, giving us not a theoretically perfect cylinder or perfect finish, but a much nearer perfect cylinder and finish than we obtained with the lathe. It gives us diameters to such small limits as to be called exact, but whoever insists that none but exact work be ground loses the very pith of grinding, which is economy. Modern grinding means cheaper cost for all work, many grades of work to suit many requirements, and cheaper turning than is possible without the use of the grinding machine.

"As a rule, the coarser the turning the greater the economy by grinding. The greatest economy is obtained by the combination of cheaper turning and grinding. It is no longer necessary to turn work smooth, straight or correctly to size and the lathe is no longer neces-

sary as a precision tool. If it has a carriage traverse of from four to ten threads per inch, has sufficient power to carry high-speed tool cuts at that feed and is well supplied with steady rests to prevent springing of the work, it is ready for co-operation with the grinding machine. It is easier with modern grinding machines and wheels to grind off a given amount of metal when in the form of crude screw threads than in any other form, and with long work having several sizes the grinding requires less time if 1/32 inches to 5/64 inch is left on the diameter for grinding than if the work is turned carefully to within 0.002 in. to 0.005 inch. In all cases, accurate turning increases the total cost of production and in some it makes the grinding very expensive. The greatest economy is usually obtained by the combination of grinding with very rough turning. Yet there are cases where the least expensive way is to grind direct without turning, notably the greater part of crankshafts of automobiles and small gas engines and very long and slender work where turning is difficult.

"It is not an easy matter to secure such rough turning as true economy requires in connection with grinding. Lack of knowledge of what is needed, coupled with the natural pride the workman takes in doing what tradition says is nice lathe work, prevents the grinding machine from doing what it is ready to do. Lathe men have not tried to remove metal by increasing the number of cuts and using fast traverse. When urged to take coarse feeds to help the grinding machine to effect a total saving, they have invariably said that they were feeding all that the work would stand. It has been demonstrated that three cuts with a carriage traverse of 6 per inch has produced certain work in 9 minutes that required 13 minutes to turn in one cut, because the work was so frail that with one cut no faster feed than 32 per inch could be taken. The rough-ridged surface was readily ground by taking 1 minute more than when the turning was finer, the net saving for the job being 3 minutes. In many cases the ridged surface requires no additional time. . . .

"There is a rich field for engineers and managers in connection with the lathe and modern grinding. Recent lathe designs provide for high speed of revolution, with sufficient power, quick change to and from back gears, and sufficient rigidity to utilize to the limit high-speed steel; but much work is not of sufficient rigidity to permit the maximum use of the tool at fast traverse and deep cuts. In addition, there are thousands of lathes of old design that will not be thrown away at once. There is, therefore, an opportunity to get much more out of present plants by cheaper turning, *because of grinding.*

"Developments warrant the conclusion that we should no longer assume that simply because a tool is a grinding wheel it cannot remove metal and size and shape work as quickly as a steel tool. Rather, we should use the steel tool when it can be made to remove metal, size and shape work cheapest, and the grinding wheel when it excels. It is no longer to be taken as a matter of course that we can turn, plane and mill faster than we can grind. After all, the real reason we remove metal is to accomplish certain finished results, not simply to secure a certain number of pounds of chips in a given time. Before long I think all progressive engineers will understand that both the grinding wheel and the steel tool have their place for metal cutting. The old thought of abrasion must give way to the new thought of cutting.

"While it is still true that poor wheels or good wheels poorly selected and wrongly used will still remove metal very slowly by abrasion, it is also true that the old-fashioned milling cutter, with fine teeth cut by hand with a file, hardened but never ground, and used in the old-time slender milling machine, would very slowly abrade the surface. The modern grinding wheel, used in a modern machine by a modern man, is just as surely a milling cutter as if it were made of steel." The microscope reveals the fact that the grinding wheel removes the metal in the form of chips, similar to those produced by the lathe and milling machine.

"The grinding wheel as now made is really a milling cutter with millions of cutting teeth. Although these teeth are not as large or as strong as the teeth of a steel cutter and therefore cannot cut as deeply, yet they are capable of cutting at much greater speed. Since there are so many more of them they are capable of much more work in a given time when the nature of the work is such that a large number of these cutting points can be used simultaneously. In some cases we can use as many as two billion cutting points per minute. Eight hundred million per minute is not uncommon and four hundred million per minute is very common. The modern grinding wheel, mounted in a good machine, can be used at a cutting speed of 6,000 or more surface feet per minute and owing to this high speed it need not cut deeply relative to the rigidity of the work. Therefore it is able to remove metal from many forms of work more quickly than the milling cutter or the lathe tool." Mr. Norton describes particularly the manufacture of automobile cams from bar stock, and the finishing of pins and bearings of automobile crankshafts, and illustrates a number of other classes of work in which the grinding machine is more economical than the lathe or milling machine.

"Automatic grinding is a late development in the field. Certain work of which large numbers of pieces are made is ground by wholly automatic means. The work is conveyed to the machine by gravity in a hopper or chute and is chucked, ground and delivered to the receptacle. In a case where formerly, at piece work, 300 per day were ground, the automatic machine grinds 4 in a single minute, about 2,300 per day. When the knowledge of grinding becomes more common and the opposition to increased production on the part of the workmen shall have been more nearly overcome, the field will be still more extended. It is worthy of more systematic co-operation and if we get together we will be rewarded with success. The engineer is the one who by education and training is best fitted to take up the important question of the field for grinding and its possible economies."

TRANSMISSION OF HEAT IN SURFACE CONDENSATION.

A SUMMARY OF THE RESULTS OF A RECENT INVESTIGATION COVERING THE WHOLE THEORY OF HEAT TRANSMISSION THROUGH CONDENSER TUBES.

George A. Orrok—American Society of Mechanical Engineers.

So long as small condensers and vacua of over two pounds absolute were the rule, designers of surface condensers were not seriously hampered by the diversity of the theories formulated by the various investigators of the laws of heat transmission through condenser tubes. But since the development of the steam turbine has caused a demand for condensers of large capacity working at vacua of less than one pound absolute, the lack of more accurate knowledge of these laws has been seriously felt. It is now made available by George A. Orrok, who has been enabled by the liberality of the New York Edison Company to complete a careful investigation of the whole theory of heat transmission through condenser tubes. Mr. Orrok's results and conclusions were reported in a long paper read before the American Society of Mechanical Engineers at the recent annual meeting, and are printed in the *Journal* for November, 1910.

The theory of the transmission of heat through metallic tubes from condensing steam to water as stated by previous investigators may be summarized as follows: "(1) The quantity of heat transmitted by a unit of surface in unit time is proportional to the temperature difference (Joule, Rankine and most of the experimenters), or to the square of the temperature difference (Werner, Grashof and Weiss) between the media on the different sides of the tube; (2) the quantity of heat transmitted is pro-

portional to some power of the water velocity ($V^{1/6}$ by Joule and Ser, $V^{1/2}$ by Hagemann and Josse, V^{1} by Stanton); (3) the quantity of heat transmitted is proportional to some power of the steam velocity or mass flow ($V^{1/2}$ by Hausbrand and Ser, mass flow by Jordan); and (4) the quantity of heat transmitted is greately affected by the amount of non-condensible vapors on the steam side of the tube (Bourne, Smith, Weighton, Morrison, McBride)."

Many of the results of the earlier experimenters have been confirmed by Mr. Orrok, who has, however, carried his investigation to a conclusion much in advance of the previous work. Its scope, as he describes it, "was to determine the heat transfer through various kinds of condenser tubes and the laws governing its variation under different conditions of steam temperature, pressure and velocity; velocity of circulating water, and mean temperature difference. In order to obtain these data, a small surface condenser was constructed with a relatively small cooling surface, and it was operated under conditions as nearly like actual condenser conditions as possible. The steam inlet, dry vacuum, and circulating water lines were so arranged and controlled that any desired vacuum, any desired velocity of circulating water, and any desired mean temperature difference could be maintained and that any one of these conditions could be varied through a considerable range quite independent of the other two. A hot well was constructed and so connected to the condenser that the temperature of the hot-well water (condensed steam) and its amount could be determined. Thermometers, pressure gauges and a water meter were installed, and a record was made of all desired data." These data are given in full in Mr. Orrok's paper.

We have not space for a more detailed description of the apparatus, which is described at great length in Mr. Orrok's report, nor can we deal with the numerical results of the 770 odd tests made during the progress of the investigation. For these data, and for Mr. Orrok's graphical presentation of the results, we must refer our readers to the original paper. Here we are concerned only with his conclusions, which we reprint in full.

The first of these is that "the heat transferred from condensing steam surrounding a metallic tube to cold water flowing through the tube is proportional to the seven-eighths power of the mean temperature difference of the water and steam temperatures. This is equivalent to the statement that the coefficient of heat transfer, U, is inversely proportional to the eighth root of the mean temperature difference.

"The coefficient of heat transmission, U, is approximately proportional to the square root of the velocity of the cooling water.

"The coefficient U is independent of the vacuum and of the velocity of the steam among the tubes or in the condenser passages. It may be proportional to the square root of the velocity normal to the tubes, but in all common cases this velocity does not vary more than a tenth part.

"The effect of air on the heat transferred is very marked indeed, particularly at high vacua, and most of this air is due to leakage through the walls and joints of the apparatus. Working from Smith's curves and certain picked tests, where the volume of air could be calculated, the effect of the presence of air in reducing the value of U is as follows:

$$U = c\left(\frac{P_s}{P_t}\right)^5$$

where P_s is the partial pressure due to the steam and P_t is the total steam and air pressure.

"Taking the heat transfer of a copper tube as 1.00, under similar conditions the transfer for other materials is approximately as follows: copper, 1.00; Admiralty, 0.98; aluminium lined, 0.97; Admiralty oxidized (black), 0.92; aluminium bronze, 0.87; cupro-nickel, 0.80; tin, 0.79; Admiralty lead-lined, 0.79; zinc, 0.75; Monel metal, 0.74; Shelby steel, 0.63; old Admiralty (badly corroded) 0.55; Admiralty vulcanized inside, 0.47; glass, 0.25; Admiralty vul-

canized both sides, 0.17. This coefficient (due to the material of the tube) will be designated by μ. Corrosion, oxidation, vulcanizing, pitting, etc., have also a marked effect in reducing the transfer. This reduction, best shown by the Admiralty tube which gave $\mu = 0.55$, may reduce the transfer at least 50 per cent.

"The foregoing conclusions may be expressed mathematically as follows:

$$U = K \frac{C \rho^5 \mu \sqrt{V_w}}{\theta^{1/4}}$$

where C is the cleanliness coefficient varying from 1.00 to 0.5; μ, the material coefficient varying from 1.00 to 0.17; ρ, the steam richness ratio P_s/P_t, varying from 1.00 to 0; V_w, the water velocity in feet per second; θ, the mean temperature difference, and K, a constant, probably about 630. The effect of the length of tube, or rather length of water travel, has not been considered and the design of the condenser must be such that there is a free steam passage to every tube.

"This expression for U is cumbersome to use and for modern turbine condenser work certain conditions may be taken as well settled. The guaranteed vacuum is usually 28 inches. The entrance circulating water is usually 70 degrees and a 20 degree temperature rise is considered economical. Under these conditions $\theta = 18.3$ and $\theta^{1/4} = 1.44$. θ calculated on the geometrical curve is 18.2. For these cases it will be nearly as accurate and much simpler to calculate θ by the logarithmic method, neglecting θ in the denominator and using 435 or 630/1.44 for K^1. The expression will then be

$$U = K^1 C P^5 \mu \sqrt{V_w}$$

"The above equation agrees well with the results of a number of tests on full size condensers under varying conditions. There appears to have been no attempt to determine the amount of air handled by the air pump in these cases, but the amounts of air indicated by the formula are such as agree with the pressures and temperature taken."

SCIENTIFIC RAILROAD MANAGEMENT.

EFFICIENT AND ECONOMICAL MANAGEMENT AS AN ALTERNATIVE FOR RATE INCREASES AS A MEANS OF INCREASING THE NET EARNINGS OF AMERICAN RAILROADS.

Louis D. Brandeis—Hearing before the Interstate Commerce Commission.

THE sensation of the recent hearing before the Interstate Commerce Commission relative to the proposed increase of railway freight rates was the statement by Louis D. Brandeis that by the application of the principles of scientific management the operating expenses of the railroads of the United States can be reduced at least a million dollars a day. Mr. Brandeis, who represented the Traffic Committee of the Commercial Organizations of the Atlantic Seaboard, in his introductory presentation of the case for the shippers, attacked the contention of the railways that the income necessary to maintain the present dividends can be obtained only through increases of freight rates, and offered as an alternative the methods of efficient and economical management which have been successfully applied in other industries. His suggestions are discussed at some length in our editorial columns this month; below we give the principal portions of his address.

"Although the burden of proof is upon the railroads to show that the proposed increases in rates are just and reasonable, their counsel have, throughout these hearings, refrained from stating the grounds upon which they rest such contention. But the testimony introduced on behalf of the railroads shows that the contention of the railroads is substantially this:

"(1) That a greater net income is necessary in order that present dividends may be maintained, or be properly increased, and that certain additions and improvements be made from surplus income, to the end that the new capital

which is required for making improvements and for increasing transportation facilities may be secured.

"(2) That this need of greater income arises from the fact that the ratio of operating expenses to gross operating revenues has risen monthly by reason mainly of the recent advances in the rate of wages, and burdens imposed through acts of Congress, such as the laws providing for safety appliances, the laws limiting the hours of labor, and the laws under which this commission has standardized railroad accounting, and required fuller reports.

"(3) That this greater net income cannot be secured otherwise than through increases in freight rates, as the possibility of economies in operation have (at least for the leading railroads) been practically exhausted.

"(4) That the proposed increases in freight rates, which are confined practically to horizontal increases of long-distance class rates, are the proper means of raising such additional net income.

"The shippers and consumers of the Atlantic seaboard take issue with the railroads on substantially each of these propositions. In the first place, we submit that even if the railroads do need additional net income, no evidence has been adduced to show that the particular increases in freight rates now under consideration are just and reasonable; and we shall offer evidence to show that the contrary is true; that the horizontal increase in class rates, as proposed, would cast new burdens, particularly upon the small producer and consumer; that it makes arbitrarily a sweeping change of long distance rates which have to a large extent been in effect for nearly a generation; changes made without evidence whether the existing rates are or are not amply compensatory; changes affecting more than 4,000 different articles made without adequate investigation into the effect upon the particular industries to which they apply; changes involving grave injustice, among other reasons, because the rates discriminate unreasonably in favor of articles to which commodity rates apply and also because they discriminate to some extent in favor of local traffic.

"We shall therefore contend that even if the railroads need additional net income, and some raise in freight rates were a proper means of securing such additional income, the commission should not approve the particular tariffs now under consideration, because the particular increases in question are not shown to be just and reasonable. In the second place, we shall offer evidence tending to show that even if the railroads need additional net income, it should be secured through greater efficiency and economy of operating instead of resorting to the dangerous expedient of raising freight rates.

"The eminent railroad presidents, who testified before your commission, have declared that further economies are practically unobtainable. To these declarations of despair, involving a vicious circle of ever-increasing freight rates and ever-increasing cost of living, we oppose the gospel of hope. As an alternative to the practice of combining to raise rates and hence to increase prices, we offer co-operation to reduce costs and hence to lower prices. This can be done through the introduction of scientific management, resulting in greater efficiency and greater economy in operation. In so saying, we offer a constructive policy of management, not personal criticism of those to whom the management of railroads is now entrusted. This greater efficiency in operation, which will follow the introduction into railroads of scientific management, must result in economies which will far more than compensate for all recent or expected increases in wages and other expenses.

"We shall show you how scientific management, when applied to the simple operation of loading a railroad car with pig iron, increased the performance of the individual worker from 12½ to 47 tons; how, when applied to shovelling coal, it doubled or trebled the performance of the shoveller. How, when applied to the operations of a machine shop, it developed, in certain operations, increases ranging from 400 to 1,800 per

cent. How, when applied to brick laying, the day's accomplishment rose from 1,000 to 2,700 brick.

"We shall show that the principles of scientific management are general in their application; that they can be introduced into practically all businesses and all departments of any business; that they have been successfully applied in private competitive businesses like machine shops and factories, steel works and paper mills, cotton mills and shoe shops, in bleacheries and dye works, in printing and in bookbinding, in lithographic establishments, in the manufacture of typewriters and optical instruments, in construction and engineering works and in activities not commonly classed as business; and that recently, to some extent, they have been introduced by the United States Government into the manufacturing department of the army.

"We shall show also that, to a very slight extent, these principles of scientific management have been applied in railroading, and that, in so far as they have been so applied, they have obtained valuable results similar to those obtained in private competitive businesses.

"And, finally, we propose to show the huge field for the application of scientific management in American railroad operation and the rich fruit in economies and improved service which may be expected to result, economies which have been estimated as aggregating in amount more than a million dollars a day.

"We shall show you how railroad operation presents an especially favorable opportunity for co-operation to reduce costs through the introduction of scientific management. The fact that the railroad business is subject in its accounting to the requirements of this commission makes it possible for the commission to require that each company ascertain and report to it the simple ultimate unit cost of each operation in every department of the railroad. The further fact that the railroad business is practically non-competitive makes it proper to publish these costs and to give to each railroad the benefit of knowing the lowest elementary unit cost of each operation attained by any railroad, and how it was attained. I say ultimate unit cost, because it is necessary to obtain the ultimate unit, the cost of the molecule in the operation, before a really reliable basis of comparison can be had. The knowledge that the average annual cost of a locomotive in repairs, renewal and depreciation on one road is $3,832.37 and on another road is $2,709.27, is a very unsafe guide in determining the relative economy of operation on the two railroads. The conditions on the two railroads and standards of renewals and depreciation may vary so that the company expending the greater sum may actually have conducted its locomotive use and repairs more economically than the company expending less. What is needed as a basis of comparison is the ultimate unit cost, the cost of turning a wheel, the cost of laying a tie or a rail; and even that relatively simple operation must again be analyzed and separated into its ultimate simple elements.

"The attainment by each railroad for each operation of the lowest cost attained by any operation would not, however, satisfy the demands of scientific management. To attain only the best that has been done presents rather the beginning than the end of the economy that scientific management contemplates. With the ascertainment of the lowest existing costs the study must be made whether there is still waste time and effort involved in the best existing method of performing that particular operation, and after such waste has been determined and eliminated, there remains the wide field of research for a better way of doing the same thing. And such a system of published comparative costs would serve not only to prevent honest waste—but dishonest graft.

"Besides economies from the introduction of scientific management, there are, as we shall show you, other economies possible in railroad operation attainable under the present system of management by the introduction of new devices, like the substitution of machines for hand labor. For instance, for comparatively small capital expenditure, large economies are believed to be possible through

the use of appropriate machinery in the handling of freight in loading and unloading, warehousing and accounting, thus not only reducing the terminal expense, but overcoming the congestion of the terminals, a condition constituting one of the most serious transportation problems.

"Returning now to the original contention made on behalf of the railroads, that a new source of net income through increased freight rates must be found, we submit that such need has not been shown to exist. And we propose to show that, in instances where such actual need may appear, it has resulted, not from the fact that present rates are too low, but from the fact that the management has, through reckless expansion or other waste, through financial inefficiency, impaired the financial condition of the company, and that the burden so arising should be borne by the stockholders through reduction of dividends and not by shippers and consumers through increases in freight rates."

THE ARMAMENT OF BATTLESHIPS.

A DISCUSSION OF THE RELATIVE EFFICIENCY OF VARIOUS NUMBERS AND ARRANGEMENTS OF GUNS, AND OF GUNS OF VARIOUS CALIBRES.

Sir William White—Society of Naval Architects—The Engineer.

JUST at the present moment, when the competition in naval armaments has pressed to the very utmost the output resources of the great armament firms in England, Germany, and the United States, the views of Sir William White, as they appear in an interesting paper on the subject of battleship armaments recently presented before the Society of Naval Architects and Marine Engineers, are of more than usual interest. A copy of the paper itself has not yet reached us, but an admirable discussion has appeared in the editorial columns of *The Engineer* for December 2, 1910, which we abstract at some length below. We are thus fortunately able to supplement Mr. Koon's paper on the *Dreadnought* type in this issue of THE ENGINEERING MAGAZINE with authoritative critical comment on a number of the designs he describes.

"The arguments in Sir William White's paper reflect very fairly the views of the two camps into which gunnery schools may be said to be divided. One is the all-big-gun one-calibre school, while the other advocates a secondary armament for battle purposes. As Sir William points out at the beginning of his paper, the fundamental idea which has governed the armaments of war ships in all ages is the desire to provide means of offence which will enable a ship to destroy her adversary in the shortest possible time with the minimum damage to herself, and active offence still constitutes the best, though not the only means of doing so. Sir William advocates the re-adoption of the 6-inch gun as a fighting weapon in association with not more than four twin centre-line turrets arranged as in the *South Carolina*, an arrangement which is said to be adopted in the new Japanese battleship now being built at Barrow.

"It is generally agreed that battle ranges have inevitably increased of late years, owing to the development of the locomotive torpedo, and to systems of fire control associated with improved gunnery. Conflicting views are held as to what the range will be. Climatic conditions and a serious intention of attaining a decisive issue, may tend to reduce the range that would be chosen by the faster all-big-gun ships. Herein lies the crux of the situation. When the earlier *Dreadnoughts* were built, their speed gave them the advantage of choosing the range. Now that there are numerous ships of this type, as well as much faster torpedo craft afloat, there is a strong tendency to develop the smaller weapons. But for what purpose? Not for battleship attack directly. For indirect attack, for keeping up a 'blanketing' fire, with the object of making it difficult for the

enemy to see the attacking ship and on the off chance of their effecting damage to unarmoured structures and communications which influence fighting efficiency they may be useful, but it becomes a question as to whether adequate value for tonnage involved is obtained by their adoption. With records of practical experience it is impossible to reconcile Sir William White's reason for believing that actual trials do not confirm the objection to mixed armaments on the ground that the simultaneous discharge of guns of different calibres must be accompanied by diminished efficiency in the control of fire and in the proportion of hits to rounds made by guns of different calibres. We hold most strongly that in the *King Edward* class, for instance, the accuracy of 6-inch fire is materially affected by the simultaneous discharge of the 9.2-inch and 12-inch guns. It suffers also in rapidity from the smoke nuisance.

"In referring to the number of heavy guns to be mounted, Sir William advocates pairs, and goes on to note the extraordinary Italian practice of mounting three triple and two twin turrets in the *Dante Alighieri* class. Triple turrets involve insuperable objections to practical gunners of the 'hit-the-target' order; beside being too many eggs in one basket they suffer from smoke interference and 'throw-off' to an excessive extent. The relationship of protective material and the adequate support of the same also receives attention. In many foreign vessels we find turret roller paths fixed directly to or supported on the vertical barbette armour—a most dangerous practice, as in action the combined efficiency of the heavy gun armament, in spite of heavy blows on the protective armor, is a primary consideration. Adequate clearance between fixed and moving portions of a turret should always be allowed in spite of the increased overall dimensions and weight necessary. Reference is made to the maximum number of heavy guns that should be carried by a warship. Here the author is on much safer ground. In tonnage value for effect obtainable, it is hard to believe that it is possible to improve on the arrangement, first adopted in the United States battleship *Michigan*, of four twin turrets on the centre line, the two inner turrets firing over the two end turrets. Such an arrangement possesses the great advantage of minimum interference between turrets due to 'blast.' The system adopted in the *Inflexible* class, in the *Von der Tann* or the Spanish battleships, of having two centre line and two echelon turrets, really reduces these vessels in practice to the status—considering broadside work only—of six-gun ships. On paper, the echelon arrangement allows three pairs of turrets to fire ahead and astern on the keel line. On board, such a discharge causes unpleasant consequences, and the limits of safe training in practice are considerably less than the extremes shown on the drawings. Of course, automatic danger signals—generally shrill buzzers by the side of the turret training levers—are supplied to warn the gun-layer when he risks his own or his neighbor's comfort from blast, but these are extremely apt to be unreliable in action, and the system of mounting guns to avoid this, even if the number of heavy guns be reduced, will probably be found best in service. The advantage conferred by confining the primary armament to the ends of a ship, as far as magazine accommodation is concerned, is very considerable. Side turrets, as in the *Dreadnought* or *Minas Geraes*, are inconvenient—the *Nassau* is very bad with four large turrets crowded together—owing to the difficulty experienced of making a good boiler and engine-room arrangement. Sir William White does not touch on the point beyond referring to the objection of mixing stokeholds and magazines, but it entails probably an additional row of boilers to make up for the staggered units cut out by an echelon arrangement, or an increased length over the machinery space to allow for a transverse magazine. This involves a corresponding addition to the length, weight, and cost of the heavy belt armor. In view of this and the question of interference, his deliberately expressed convictions that in no case is it desirable to mount more than eight heavy guns in a single ship, and that these are best arranged in four positions, as in the *Michi-*

gan class, will meet with less criticism than his third view that they should be supplemented by a powerful and well protected secondary armament. A large number of naval officers want a protected 6-inch battery reintroduced, in spite of their expressed conviction that its fire may be discounted at ordinary battle ranges when acompanied by a 12-inch gun fire. Here is where Sir William White takes an opposite view. A secondary battery mounted as in the *Michigan* on the upper deck is, in our opinion, vastly better than the corresponding main deck battery of the *Delaware*. With, however, the smoke nuisance from the heavy guns, the continual anticipation of blast effect from overhead, and the lower rate of fire inevitable from these causes, as well as from the desire for accuracy, it is hard to agree with him. The naval desire for the reintroduction of the 6-inch gun arises from a belief that it is a better anti-torpedo gun than the 4-inch. Opinions on this point also differ widely. If the increased calibre of heavy guns tends to put up battle ranges, then it probably is; but the 4-inch should also be retained, in our opinion, for mounting in the superstructure.

"At the conclusion of his paper Sir William White turns to the important point of future gun calibre, and draws a trenchant parallel between present practice and that of twenty years ago. All the arguments that held good for the increase from 12-inch to 13.5-inch hold good for an early advance to 15-inch or 16-inch. Such a gun is being made, we believe, at the presnt time. No argument is raised against such a calibre, except that of larger or more costly ships. This has never been heeded. Warships of all kinds are generally smaller than merchant vessels, and for many years the largest have never exceeded about 60 per cent. of the greatest mercantile displacement. There are at present at least four ships being built with over 60,000 tons full load displacement, and an increase in warship size is inevitable in the early future. So it is with speed. The *Von der Tann* and *Lion* will set examples of a far-reaching kind. Nothing is said of the tactical influence of speed or armament in the paper under review, but it is obviously considerable. Meanwhile, in spite of Sir William White's generous treatment of the subject, we feel assured that the big-gun school, adhering to the results of their practical experience, will remain unconvinced that for fighting purposes anything less than the biggest convenient gun is worth having."

THE PREVENTION OF COAL DUST EXPLOSIONS.

A REVIEW OF THE FACTORS AFFECTING EXPLOSIBILITY, THE CONDITIONS AFFECTING PROPAGATION OF EXPLOSIONS, AND REMEDIES FOR COAL DUST.

George S. Rice—United States Geological Survey.

A MONOGRAPH of nearly two hundred pages bearing the title, "The Explosibility of Coal Dust," recently issued as Bulletin 425 of the United States Geological Survey, gives an exhaustive treatment of the theory and prevention of coal-dust explosions, taking into account the results of investigations in various countries and the literature of the subject up to the end of 1909. More than half of the Bulletin is the work of George S. Rice; the remainder comprises special contributions by J. C. W. Fraser, on laboratory investigations of the ignition of dust in Europe and the United States; by Axel Larsen, who reviews the coal-dust investigations at European testing stations; by Frank Haas, who discusses the use of exhaust steam as a preventive of dust explosions; and by Carl Scholz, on the use of steam and water sprays in Oklahoma mines. The main topics dealt with by Mr. Rice include an historical review of the coal-dust question in Europe and the United States, the origin and distribution of coal dust, preliminary experiments with explosible dusts at the Pittsburg testing station, the humidity of mine air, and the various remedies for

coal dust which have been proposed and put in practice. The present review is concerned only with the tentative conclusions offered by Mr. Rice as to the factors affecting explosibility, the conditions affecting propagation of explosions, and the advantages and disadvantages of the proposed remedies.

"The outward circumstances under which coal dust will explode may be summed up as follows: Sufficient dust must be brought into suspension by a preliminary shock or concussion producing a violent air wave; or else the dust must be so minute that it is already suspended in a dense enough cloud at the moment when the flame impinges. The latter effect is produced only under some peculiar circumstances by which a large amount of fine coal dust is thrown into a strong air current and carried to the igniting flame. The former effect may be produced by a heavy shock like that from a falling body, but is much more likely to result from a preliminary explosion of firedamp or, more commonly, of an explosive.

"The weight of coal dust that must be thrown into suspension to permit propagation of an explosion depends on (*a*) the percentage of volatile combustible constituents; (*b*) the amount of contained and adhering moisture; (*c*) the presence of foreign substances like stone dust; and (*d*) the size of the dust particles, the effect of which is twofold—the smaller the particles the more easily the air concussion can raise them, and the more surface is exposed for the evolution of gas.

"The minimum density of the dust cloud necessary to propagate an explosion evidently varies with the initial cause as well as with the character of the dust. Using 190-mesh bituminous dust, M. Taffanel obtained explosions regularly with a density of 70 grams per cubic metre (0.07 ounce per cubic foot), and in one instance obtained propagation with as low a density as 23 grams per cubic metre (0.023 ounce per cubic foot). In the experiments at the Pittsburg station with 200-mesh dust from the Pittsburg coal seam, in a much larger gallery, but also with far larger charges of explosive, two propagations were obtained with as low a dust density as 32 grams per cubic metre (0.032 ounce per cubic foot). Density tests with the coarser sizes have not yet been made in the Pittsburg station.

"The experiments with wetted dust at the Pittsburg station have been very instructive. Where there is a large amount of dry coal dust, judging from the Pittsburg experiments, a humid atmosphere has little effect on ignition of dust or propagation of an explosion. A long continuance of the humid conditions renders the coal dust moist and inert, but the presence of moisture in the air at the moment of explosion is not sufficient to prevent an explosion; that is, not enough moisture is carried by the mine air to reduce materially the temperature of the flame." The weight of vapor in fully saturated mine air at ordinary mine temperature, say 65 degrees F., carrying coal dust in suspension in a cloud of moderate density, say 200 grams per cubic metre, is but 7.8 per cent. of the weight of the dust. "The Pittsburg experiments with wetted dust showed that several times this percentage of moisture in the dust, in addition to a nearly saturated atmosphere, was required to prevent propagation. Probably with a low dust density the relative humidity of the air would be an important factor in tending to prevent the initiation of an explosion. However, *the great purpose of artificially humidifying mine air is that it may serve as a vehicle for carrying water to the dust.*

"When the dust is abundant, the effect of high ash content, unless that content is excessive, is apparently not noticeable. The upper limit has not yet been closely defined by experiment. The effect of intimately mixing coal dust with shale dust or stone dust has also not been fully determined experimentally. The few tests in this direction conducted at the Pittsburg station have been with 'road dusts' or other coarse mixtures, and the tests with these indicate that the amount of the inert substance has to be very large, possibly equal to the amount of pure coal dust. The tests with finely pulverized stone dust in the Altofts ex-

periments have been directed to supplanting or covering up coal dust in certain zones, but not to mixing stone dust with the coal dust."

The methods put forward for the prevention of coal-dust explosions may be divided into two classes. The object of the methods of the first class is to render the dust inert; of the second class, to prevent explosions from blown-out shots and to limit initial explosions. In the first class six methods may be noted: (1) Loading and cleaning up dust; (2) sprinkling from water cars; (3) application of calcium chloride and other deliquescent salts; (4) sprinkling and washing down with hose and nozzle; (5) the use of pipe lines and permanent sprinklers; and (6) humidifying the intake air current by steam sprays. The second class comprises three methods: (1) the use of quick-flaming or short-flaming ("permissible") explosives; (2) coating the walls and floor of the passageways with rock dust, either wholly or in zones; and (3) limiting the extent of explosions by the construction of brick or concrete linings of definite length and intervals and keeping them perfectly clean.

Dealing with these nine methods in order, "cleaning up coal dust and sending it out of the mine is a plan used more or less under all systems, but applied only to large masses of dust. The plan cannot reduce the quantity below the danger point." Sprinkling the roadway by means of water cars was the earliest method employed for watering coal dust. "Water cars with force sprinklers, in which the pressure is produced by pump or air pressure, if used frequently and thoroughly, are good. The great danger is that they will not be so used throughout all the mine, owing to their interference with the haulage of coal, and frequently owing to the lack of tracks in the air course or manways. When used intermittently the water-car system is useless because the dust is not wetted; as the drops of water do not mix with it, they are exposed to the air currents and quickly dry up."

The use of hygroscopic or normally deliquescent materials, such as calcium chloride and similar salts, to promote the retention of water by coal dust was suggested as early as 1879, but attracted little attention until the last few years. The method "has not yet been sufficiently tested to permit a conclusion as to its effectiveness in preventing explosions. If it renders the dust merely dampish—that is, not sufficiently moist to prevent explosions—it may improve the sanitary condition and lessen the quantity of float dust. It may also prove to be effective in supplementing intermittent sprinkling, enabling the dust to absorb drops of water that would otherwise be taken up by the air current.

"Thorough washing down of roof and walls with hose is required by the mining laws in Germany, and in this country in Utah. If thoroughly and frequently done it is undoubtedly most effective. The difficulty is that usually it is not done systematically and thoroughly. It is a system that cannot be effectively applied to shaly or weak roofs without resulting in many falls and great cost of timbering.

"Using permanently located sprinklers, attached to pipe lines and running continuously, but with a flow that can be varied according to need, is very effective in saturating the mine air within a moderate distance of each sprinkler, and through this means gradually wetting the dust. One of the great merits of the system is that the sprinklers can be distributed where most needed; that is, where there is a tendency to produce the most dust or where the humidity of the air current is lower than it should be. A disadvantage in some mines is that the moisture causes falls of roof. Where there is roof material that will come down, or fire-clay floor that will swell immediately on contact with water, in order to use sprinklers it may be necessary to introduce brick or arched linings, sometimes with concrete floor and sump, and to place individual sprinklers in the lined sections. The linings would serve two purposes—to catch any condensed water from the sprays and to provide a damp and dust-free zone, limiting a possible dust explosion from either side. The use of more complete zonal linings

is well worthy of consideration for long-lived mines or long-lived entries (particularly the main entries), not alone as a dust remedy, but also for fire protection."

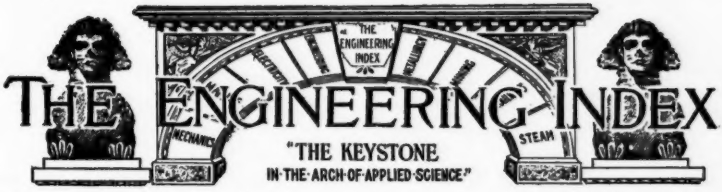
The use of exhaust-steam sprays is treated extensively in the Bulletin by Frank Haas and Carl Scholz. Here, however, we give in abstract only Mr. Rice's estimate of their value. "Humidifying the intake air current with exhaust-steam sprays is much the easiest and cheapest method of introducing moisture into a mine where the ventilating fan is run by a steam engine. The quantity of steam that it is necessary to use in the fan engine for ordinary air-ventilating pressures is sufficient to humidify the air in moderately cold weather, but in extreme cold weather is insufficient. Therefore it must be supplemented by live steam, or, as suggested by Mr. Frank Haas, in order to insure that it is used, by passing more steam through the engine. The same result could be accomplished by passing the steam through a registering meter."

The disadvantage of steam sprays is the fogging of the air current in cold weather, which causes conditions of discomfort and danger in the haulage ways. A blowing system of ventilation, utilizing the haulage way for the return air and placing the steam sprays on the air way at the intake, obviates this difficulty, but manifestly it cannot be safely used in gassy mines or in mines liable to an outburst of gas, particularly when electric haulage is employed. In such mines the only alternative is to have an additional entry for the return air, making the ventilation in the haulage way "neutral," or passing through it a very small supply of fresh air, an impossible condition in most old mines. The decision as to the use of the steam-spray system must depend on whether the mine makes sufficient gas to prevent the return air being passed through the haulage way. A compromise method is to use steam sprays in the haulage way at night only, water sprays being used only on the day shift when haulage is in progress.

The opinion is widely held that the use of exhaust steam for humidifying would be especially severe on the roof. This is not generally true. "The condition of humidity obtained by its use is very uniform. Where humidifying is not done it is the alternate drying out and wetting due to the changes in weather that causes most of the trouble. The roof is not subjected to any more severe conditions by steam or water sprays than in spring, when hot, moist air enters the mine. Later in the summer during the hot weather the same degree of moisture prevails, but the roof, becoming acclimated, as it were, to this condition, is not as likely to fall as during the spring, when the change of temperature and humidity took place. If, when cold weather comes, the humid condition of summer is maintained by introducing sprays, the roof will not be subject to violent changes in humidity.

"The use of stone dust is the most recent suggestion for either preventing or limiting explosions of coal dust. As the method is only in the experimental state, it is too early to express any decided opinion. The results at Altofts appear very favorable. Not all the mines in this country provide a suitable stone for grinding, but burned dirt piles or clay or sand are nearly always available, and to a limited extent, thoroughly burned ashes from the boiler plant. The method is not so adaptable to room and pillar workings as to the long-wall system, but it may prove a valuable alternative remedy for coal dust where the humidifying methods are considered inapplicable on account of danger to the roof, or in those mines in the arid parts of America where water for humidifying is not available.

"If in addition to wetting coal dust throughout a mine by one of the foregoing methods, 'permissible' explosives are used for shooting coal at the face, or for brushing or grading the roadways, the chances of starting a wide-sweeping mine explosion are reduced to a minimum. As a means of prevention of dust explosions, the writer would place the employment of permissibles at the head"



The following pages form a *descriptive* index to the leading and special articles of permanent value published currently in the Transactions of all the important engineering societies of both Europe and America, and in all the leading engineering journals of the world—in the English, French, German, Dutch, Italian, and Spanish languages.

The term *descriptive* is used because the definite purpose of each index note is to indicate clearly the character and purpose of the article or paper described; and with that in view we give the following essential information about every publication:

(1) The title of the article,
(2) The name of its author,
(3) A descriptive abstract,
(4) Its length in words,
(5) Where published,
(6) When published,
(7) *We supply the article itself, if desired.*

☞ The full text of every article described in the Index, together with all its illustrations, can usually be supplied by us.—See the "Explanatory Note" at the end of the Index, where also the full titles of the principal journals indexed are given.

NOTE—The busy engineer will also observe that the Index is conveniently classified into the larger divisions of engineering science, to the end that the reader may quickly turn to what concerns himself and his special branches of work. By this means it is possible, within a few minutes' time each month, to learn promptly of every important article published anywhere in the world, in any language, upon the subjects claiming one's special interest.

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CIVIL ENGINEERING.

BRIDGES.

Bascule.

Construction of the Kinzie St. Drawbridge (Chicago) and Its Deep Foundations: Chicago & Northwestern Ry. W. H. Finley. Description of methods adopted in constructing this bascule bridge over the Chicago river. Ills. 3500 w. Eng News—Nov. 24, 1910. No. 18873.

Erection.

Cribbing for Small Spans from the Top of Piers. A. van der Meersch. Illustrates and describes methods adopted on work in West Africa. 600 w. Engr, Lond—Oct. 21, 1910. No. 18302 A.

Piers.

The Beaver Bridge Piers. Illustrated description of piers for the double-track cantilever bridge over the Ohio River at Beaver, Penn. 2000 w. Eng Rec—Nov. 19, 1910. No. 18663.

Quebec.

The Removal of the Debris of the Old Quebec Bridge. H. P. Borden. Illus-

We supply copies of these articles. See page 670.

trated description of methods of cutting apart by the use of oxy-acetylene, and of dynamite. 1600 w. Eng News—Nov. 10, 1910. No. 18453.

The Removal of the Debris of the Old Quebec Bridge. Gives illustrations showing the work at various stages, with descriptive notes. 1800 w. Engr, Lond—Nov. 18, 1910. No. 18905 A.

Tests of Nickel-Steel Models of Compression Members in the Official Design of the New Quebec Bridge. Illustrated detailed description of tests, with editorial comment. 6000 w. Eng Rec—Nov. 19, 1910. No. 18660.

Reconstruction.

Reconstruction of the Steubenville Bridge. Illustrated description of the replacing of the steel superstructure in an unusual way without interrupting traffic. Also editorial. 5000 w. Eng Rec— Nov. 26, 1910. No. 18951.

Reinforced Concrete.

The Stadhouder Bridge, at the Hague (De Stadhoudersbrug te 's Gravenhage). Y. M. D. Kentie. A detailed description of the design and construction of a reinforced-concrete arch highway bridge of 24 metres span. Ills. 9000 w. De Ingenieur—Oct. 29, 1910. No. 18936 D.

The Replacement of the Reichsstrasse Bridge over the Passer in Meran (Der Umbau der Reichsstrassenbrücke über die Passer in Meran). Rudolph von Hartlieb. Describes the erection of a concrete-arch highway bridge, replacing a steel truss. Ills. 2500 w. Oest Wochenschr f d Oeffent Baudienst—Oct. 1. 1910. No. 18788D.

See also Steel, and Trestles, under BRIDGES.

Steel.

The Walpole Bridge. Illustrated description of a highway bridge across the Connecticut River, having unusual lengths for plate girder spans, and other interesting features. 1200 w. Eng Rec—Nov. 12, 1910. No. 18511.

Steel-Concrete Arch Bridge. Illustrated description of a recently completed structure in Syracuse, N. Y. Steel arches enclosed in concrete, supporting reinforced-concrete floor slabs. 1200 w. Munic Jour & Engr—Nov. 2, 1910. No. 18356.

See also Reconstruction, under BRIDGES.

Trestles.

Converting a Steel Trestle Into a Reinforced-Concrete Trestle. Illustrated description of work on the Wabash Ry. near St. Charles, Mo. 1000 w. Eng News—Nov. 10, 1910. No. 18450.

Reinforced Concrete Trestles for Railways. C. H. Cartlidge. Illustrates and describes structures devised to replace timber or wooden pile trestles for shallow openings. Discussion. 9800 w. Jour W Soc of Engrs—Oct., 1910. No. 18830 D.

Viaducts.

Reinforcement of the Pecos River Viaduct: Southern Pacific Ry. Illustrates and describes particulars of the recent reinforcement of this structcre on the So. Pacific Ry., in Texas. 1700 w. Eng News—Nov. 3, 1910. No. 18347.

CONSTRUCTION.

Concrete.

Tests to Determine the Effects of Frost on Concrete and Methods of Concrete Work in Freezing Weather. J. H. Chubb. Shows that winter work cannot be handled the same as summer work, but with proper precautions can be safely carried on. 3000 w. Engng Con—Nov. 23, 1910. No. 18887.

Forms for Concrete. J. D. Stevenson. Deals particularly with forms used in concrete construction, especially the filtered water reservoir of the Pittsburgh Filtration Works. Discussion of this paper includes F. E. Field's paper. Ills. 12000 w. Pro Engrs' Soc of W Penn—Oct., 1910. No. 18822 D.

See also Excavation, under CONSTRUCTION.

Contractors' Plants.

Contractors' Plants—Types, Layout and Methods of Operation. Frederick E. Field. Introductory remarks with a consideration of the layout of plant and methods of operation in several parts of the work of construction of the filtration works of the City of Pittsburgh. Ills. 7800 w. Pro Engrs' Soc of W Penn—Oct., 1910. No. 18821 D.

See also Concrete, under CONSTRUCTION.

Earth Pressures.

Earth Pressures in Rock Tunnels. (Ueber die Zerstörungen in tunnelartig gelochten Gesteinen). A. Leon and F. Willheim. A study of stress distribution in the walls of tunnels by means of tests of rocks pierced with holes similar in shape to tunnel sections. Ills. 4000 w. Oest Wochenschr f d Oeffent Baudienst —Oct. 29, 1910. No. 18790 D.

Excavating Machinery.

English Navvies and American Steam Shovels. A. F. Dickinson. An illustrated comparative study of excavating machines. 2200 w. Cassier's Mag—Nov., 1910. No. 18611 B.

See also Shovels, under ELECTRICAL ENGINEERING, POWER APPLICATION.

Excavation.

New Rules of Measurement for Excavation and Concrete Work in Chicago. Rules of interest to contractors, reprinted from the 1910 Guide of the Masons and Contractors' Assn. 2000 w. Engng Con—Nov. 16, 1910. No. 18592.

Methods of Excavating Canal Prism, Using a Bridge Conveyor Excavator, with Costs of Work for Twenty-four Consec-

We supply copies of these articles. See page 670.

utive Months. Illustrated account of work on Contract 6 of the N. Y. State Barge Canal. 1800 w. Engng-Con—Nov. 23, 1910. No. 18888.

Fireproof.

Examples of Simple and Efficient Cement and Steel Fireproof Construction. H. M. Naugle. Illustrates and describes a system in which the frame of the structure is made to serve as a combined form and reinforcement. 1200 w. Cement Age—Nov., 1910. No. 18621.

Fireproof Walls in Reinforced Concrete (Feuersichere Wände aus Eisenbeton). R. Saliger. A discussion of the fire-resisting properties of concrete and of wall design in fireproof structures. 2600 w. Beton u Eisen—Oct. 27, 1910. No. 18797 F.

See also Regulations, under CONSTRUCTION.

Foundations.

Foundations of the Municipal Building, New York City. Illustrated detailed descriptions of the important and remarkable foundations for a 25-story-and-tower steel-frame office building, explaining conditions and work. 6000 w. Eng News—Nov. 17, 1910. No. 18605.

Completion of Foundations for the Municipal Building, New York. Illustrated description of unusual caisson work Also editorial. 3500 w. Eng Rec—Nov. 5, 1910. No. 18407.

Gas Holders.

Brick, Concrete and Steel Holder Tanks. Herbert W. Alrich. Read before the Am. Gas Inst. Discusses in detail tanks above and below ground, and brick, concrete and steel as materials, favoring steel tanks above ground. Ills. 11700 w. Am Gas Lgt Jour—Nov. 14, 1910. No. 18517.

Gas Holders (Gasaufspeicherung). Herr Scheuss. A review of German practice in the design and construction of gas holders. 3200 w. Zeitschr d Ver Deutscher Ing—Oct. 1, 1910. No. 18919 D.

Piling.

The Steel Sheet Pile in the South. J. F. Springer Brief review of the development, and illustrated description of applications. 4000 w. Mfrs' Rec—Nov. 3, 1910. No. 18345.

The Making, Driving and Jetting of Reinforced Concrete Piles. Frank B. Gilbreth. Illustrates and describes methods used. Also general discussion. 15000 w. Jour Am Soc of Engng Con—June, 1910. No. 18309 N.

The Konus Concrete Pile (Der Konus-Betonpfahl). W. Siegfried. A detailed description of a new system of pile foundation. Ills. 4000 w. Schweiz Bau—Oct. 29, 1910. No. 18772 B.

Regulations.

Building Regulations and Fire Insurance (Bouwverordening en Brandgevaar in Verband met Brandverzekering). W. H. A. Elink Schuurman and W. Meijer Cluwen. A discussion of the technical aspects of fire-insurance rating. Ills. 10800 w. De Ingenieur—Oct. 22, 1910. No. 18935 D.

Reinforced Concrete.

Methods of Computing Reinforced Concrete Flat Slabs. Louis F. Brayton. Read before the Nat. Cement Users Assn. States the views of the author in regard to the form the surface takes, and explains methods of calculation. 2500 w. Engng-Con—Nov. 2, 1910. No. 18337.

The Design of Reinforced-Concrete Slabs for Uniformly Distributed Loads (Berechnung vierseitig freiaufliegender rechteckiger Platten mit gleichmässig verteilter Belastung). J. N. Dorner. Mathematical. Ills. 2900 w. Beton u Eisen—Oct. 27, 1910. No. 18799 F.

A Reinforced-Concrete Cold Storage Warehouse at Jersey City, N. J. Arthur G. Hoadley. Illustrated description of a recently completed adidtion to the plant of the Union Terminal Cold Storage Co. 1500 w. Eng News—Nov. 3, 1910. No. 18351.

The Maverick Cotton Mills at East Boston. Illustrated description of reinforced concrete textile mills of large size, now under construction. 1600 w. Eng Rec—Nov. 5, 1910. No. 18408.

See also Fireproof, Piling, Retaining Walls and Steel, under CONSTRUCTION; Reinforced Concrete, under MATERIALS OF CONSTRUCTION; Dams, under WATER SUPPLY; Wharves, under WATERWAYS AND HARBORS; and Poles, under ELECTRICAL ENGINEERING, TRANSMISSION.

Retaining Walls.

The Design of Retaining Walls, Adapted from George Christoph Mehrtens, "Vorlesungen Ueber Static der Baukonstructionen und Festigkeitslehre." George M. Purver. Mathematical demonstration. 3500 w. Engng-Con—Nov. 2, 1910. No. 18339.

Recent Retaining Wall Practice, City of Pittsburgh. Charles M. Reppert. Reviews the methods used in the design and construction of these works, giving cost data. Ills. 13500 w. Pro Engrs' Soc of W Penn—Oct., 1910. No. 18823 D.

Enlargement of the Track Space at the Saint Lazare Station, Paris (L'Elargissement du Goulot de Saint-Lazare, à Paris). Charles Rabut. Describes the construction of a reinforced-concrete retaining wall with hanging sidewalk which gives more tracking space. Ills. Serial, 1st part. 4200 w. Génie Civil—Oct. 1, 1910. No. 18718 D.

Steel.

Structural Steel Details of the Curtis Building. Details of girders, trusses, and various connections of a 12-story steel

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cage building in Philadelphia, are illustrated and described. 3500 w. Eng Rec—Nov. 5, 1910. No. 18405.

Packard Motor Car Company's Service Building, Queensboro, New York City. Illustrated detailed description of an 8-story building of steel and reinforced-concrete. 1400 w. Horseless Age—Nov. 16, 1910. No. 18670.

Permissible Stresses in Steel for Buildings and Bridges (Ueber zulässige Spannungen im Eisen, im Hoch- und Brückenbau). A discussion of modern practice in designing steel members. Ills. 5400 w. Beton u Eisen—Oct. 7, 1910. No. 18796 F.

Tunnels.

Excavation of the Wallkill Pressure Tunnel—Catskill Water Supply to New York City. Illustrated description of methods of rock tunnel driving. 2500 w. Engng-Con—Nov. 9, 1910. No. 18442.

Driving Spiral Tunnels on the Canadian Pacific Ry. The method of tunnel driving is illustrated and described. The two spiral tunnels between Field and Hector, B. C. 2500 w. Eng. News—Nov. 10, 1910. No. 18454.

See also Earth Pressures, under CONSTRUCTION.

MATERIALS OF CONSTRUCTION.

Brick.

Causes of and Methods of Preventing Efflorescence on Brickwork. From a paper by A. F. Graves-Walker. 1500 w. Engng-Con—Nov. 23, 1910. No. 18891.

Cement.

The Use of Cement and Its Substitutions. Ernest McCullough. Information concerning these materials. 2000 w. Min Wld—Nov. 12, 1910. No. 18545.

Concrete.

See same title, under CONSTRUCTION.

Lead.

The Art and History of British Leadwork. Lawrence Weaver. An illustrated lecture on the history of leadwork and its uses, especially in architecture. 4500 w. Jour Soc of Arts—Nov. 4, 1910. Serial. 1st part. No. 18549 A.

Paints.

The Permeability of Paint Films. Henry A. Gardner. Gives results of a series of tests made to determine the water excluding value of various pigments. 500 w. Jour Fr Inst—Nov., 1910. No. 18698 D.

Alternatives to the Use of White Lead. Noel Heaton. Read before the Nat. Assn. of Master Decorators, at Newcastle. Examines the claims of other white pigments as compared with white lead. 3500 w. Archt, Lond—Nov. 4, 1910. Serial, 1st part. No. 18553 A.

Reinforced Concrete.

Investigations on the Slip of Rods Imbedded in Concrete. H. Burchartz. Reports results of tests made by Dr. Ing. E. Preuss, and states the conclusions drawn. 1200 w. Eng Rec—Nov. 12, 1910. No. 18512.

Ferro-Concrete. Editorial review of the interim report of the committee appointed by the Inst. of Civil Engrs. 2000 w. Engng—Oct. 28, 1910. No. 18498 A.

Reinforced Concrete (Gewapend Beton). S. G. Everts. A review of the development of this material, with some notes on modern practice. Ills. 5400 w. De Ingenieur—Oct. 15, 1910. No. 18934 D.

Timber.

Air Circulation in Lumber Driers. Information concerning drying methods and driers. 2800 w. Wood Craft—Nov., 1910. No. 18346.

The Commercial Hickories. Anton T. Boisen and J. A. Newlin. Discusses their economic importance, the supply, lumbering, mechanical properties, &c. Ills. 18000 w. U. S. Dept of Agri, Bul 80—1910. No. 18310 N.

Timber Preservation.

Some Notes on Methods and Costs of Chemically Treating Cross Ties. Gives results of studies made in connection with track reconstruction of Chicago street railways. 4500 w. Engng-Con—Nov. 23, 1910. No. 18890.

Creosoting Plant of the Pacific Creosoting Co., Eagle Harbor, Washington. General view and description of the plant, with specifications for creosoting piling. 1500 w. Eng News—Nov. 3, 1910. No. 18348.

MEASUREMENT.

Astronomical Observations.

Method of Determining the Meridian from a Circumpolar Star at Any Hour. Eugene R. Rice. Describes a method needing only one observation, and from it azimuth, latitude and sidereal time are computed. 2500 w. Brit Am Inst of Min Engrs—Nov., 1910. No. 18838 F.

Leveling.

Precise Leveling in the Southwest. Henry W. Maynard. Describes difficulties met and the manner in which the regular method of leveling was adapted to the conditions. 2500 w. Cornell Civ Engr—Nov., 1910. No. 18829 C.

Paving-Brick Testing.

Rattler Test for Paving Bricks. Describes investigations in progress to eliminate defects in this test. Ills. 2000 w. Munic Jour & Engr—Nov. 16, 1910. Serial, 1st part. No. 18591.

Stream Gauging.

Stream Measurements for the Dominion Government in Alberta, Sask. Abbreviated from report by Mr. Sauder. Illustrates and describes the hydrographic work of the Government. 3500 w. Can Engr—Nov. 3, 1910. Serial. 1st part. No. 18387.

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Surveying.

Insurance Surveying and Map Making. R. P. Getty. Information concerning the making of the records of municipal fire risks. 8500 w. Cassier's Mag—Nov., 1910. No. 18612 B.

See also Leveling, under MEASUREMENT; and Photography, under MECHANICAL ENGINEERING, MACHINE ELEMENTS AND DESIGN.

MUNICIPAL.

Accounting.

Municipal Accounts. Richard M. Chapman. Explains the principal characteristics of public accounts, the difference between fund accounts and cash accounts, and matters relating to this subject. 4000 w. Jour of Acc—Nov., 1910. No. 18548 C.

American Cities.

American City Growth: Causes and Effects. Richard H Edmonds. Address before the Phila. Chap. of the Am. Inst. of Banking. Discusses the economic cause and effect of the great increase in urban population. 4000 w. Mfrs' Rec—Nov. 10, 1910. No. 18421.

City Planning.

City Design and Transportation. Gives abstracts of opinions of M. Wattmann, as expressed in a paper read before the Int. St. and Interurban Ry. Assn. at Brussels. 2000 w. Eng Rec—Nov. 19, 1910. No. 18661.

Drainage.

A Velocity-Reducing Drainage Outfall. Illustrates and describes levees, ditches and conduits designed to prevent flooding near Summit, Illinois. 1200 w. Eng Rec—Nov. 12, 1910. No. 18515.

Industrial Wastes.

The Sewerage Question and Treatment of Trade Effluents. John D. Watson. Read before the Com. of Engrs. & Surv. Discusses conditions in England, the laws and need of action. 2500 w. Plumb & Dec—Nov. 1, 1910. No. 18554 A.

The Disposal of Cheese Factory Waste. From the annual report of the Ontario Provincial Board of Health for 1909. Discusses the problems involved and gives descriptions of two plants. 3300 w. Can Engr—Nov. 3, 1910. No. 18386.

Pavements.

Bituminous Pavements. Patented and Otherwise. E. A. Kingsley. Read before the Am. Soc. of Munic. Imp. Remarks on the early use of this material and the modern pavements. Also reply by George C. Warren. Ills. 3500 w. Munic Engng—Nov., 1910. No. 18808 C.

Asphalt-Pavement Specifications. Report of recommendations by the Committee of the Am. Soc. of Munic. Imp. 5000 w. Munic Jour & Engr—Nov. 2, 1910. No. 18357.

Close Jointed Heavily Grouted Granite Block Pavement. A report of work at Newark, N. J., with extracts from specifications. 2800 w. Engng-Con—Nov. 16, 1910. No. 18593.

Pavements of Erie, Pa. Faulkner G. Lynch. Read before the Am. Soc. of Munic. Imp. Information concerning the kinds of pavement, the cost, maintenance, &c. 1800 w. Munic Engng—Nov., 1910. No. 18809 C.

See also Paving-Brick Testing, under MEASUREMENT.

Public Baths.

See also Plumbing, under MECHANICAL ENGINEERING, HEATING AND COOLING.

Refuse Disposal.

The First Garbage Reduction Works Built by an American City; Columbus, Ohio. Illustrated detailed description of the plant and its equipment. 3500 w. Eng News—Nov. 17, 1910. No. 18609.

The Columbus Municipal Garbage Reduction Plant. Irwin S. Osborn. The plant and its equipment are illustrated and described in detail. 3500 w. Eng Rec—Nov. 19, 1910. No. 18664.

Milwaukee Garbage Destructor. Illustrated description of one of the latest plants, in which the garbage is incinerated without the aid of fuel other than that found in the refuse. 1500 w. Power—Nov. 29, 1910. No. 18966.

New Refuse Destructor and Sewage Ejector Works in Guildford. C. G. Mason. Read before the Inst. of Munic. & Co. Engrs. Illustrates and describes the buildings and their equipment. 4000 w. Surveyor—Oct. 21, 1910. No. 18289 A.

Roads.

Experiments in Binding Gravel and Crushed Gravel with Tar and Asphalt and in Constructing a Water Bound Road of Gravel. A report of experimental roads constructed by the Ohio Highway Department. 2500 w. Engng-Con—Nov. 2, 1910. No. 18338.

Testing Materials for Use on Highway Construction. A. F. Armstrong. Describes laboratory tests for the different materials used to secure the better grades. 5000 w. Cornell Civ Eng—Oct., 1910. No. 18274 C.

Tests of Various Road Surfacing Materials by the Ohio State Highway Department. Describes the test road for determining the wearing qualities of the various patented preparations for surfacing macadam roads. 6000 w. Eng News—Nov. 10, 1910. No. 18451.

Notes on Road Construction. W. Calder. Read before the Melbourne Univ. Engng. Soc. Information concerning methods employed in the Prahran Municipality and results of the writer's experience. Ills. 9500 w. Surveyor—Nov. 18, 1910. No. 18983 A.

Highway Dust Reduction in the Urban District of Alton. G. Bertram Hartfree.

Read before the Inst. of Munic. & Co. Engrs Reviews the various experiments made to allay dust, their results and cost. 4500 w. Surveyor—Oct. 28, 1910. No. 18489 A.

Country Roads. R. J. Harding. Brief discussion of the change in methods made necessary, and the organization and management of the State highways of New York. Ills. 1000 w. Cornell Civ Eng—Oct., 1910. No. 18275 C.

A Few Facts Concerning the Ithaca and Columbus Experimental Roads. Charles H. Hoyt. Illustrated description of the construction of the two experimental roads named. 1500 w. Cornell Civ Eng—Oct., 1910. No. 18273 C.

Rock Crushing.

The Laurin & Leitch Rock-Crushing Plant. Paul C. Van Zandt. An illustrated description of a Canadian plant of interest on account of its size and cost in proportion to the work to be done, and for many unusual features. 3000 w. Eng Rec—Nov. 9, 1910. No. 18665.

Sanitation.

The Declining Death Rate and the Engineer. Editorial on the death rate of the United States for 1909, as shown by statistics gathered by the U. S. Census Bureau. 2500 w. Eng News—Nov. 10, 1910. No. 18455.

Septic Tanks.

Theory, Construction, and Operation of Septic Tanks. Information from a bulletin prepared by N. D. Baker. 2200 w. Met Work—Nov. 26, 1910. No. 18884.

The Present Use of the Septic Tank. Henry N. Ogden. Read before the Am. Soc. of Munic. Imp. Brief review of the development of the septic tank, explaining its value and limitations. 1600 w. Munic Engng—Nov., 1910. No. 18805 C.

Sewage Disposal.

Modern Aspects of Sewage Purification. Ernest McCullough. Historical review of sewerage work and methods. 3500 w. Mfrs' Rec—Nov. 24, 1910. No. 18857.

Sewage Sludge and Its Disposal. A. B. Ogden. The writer's remedy is to utilize sewage sludge for manurial purposes, and he gives information showing success. 4500 w. Surveyor—Nov. 18, 1910. No. 18984 A.

The Agricultural Use and Value of Sewage. J. A. Voelcker. Abstract of a paper before the Assn. of Mgrs. of Sewage Disposal Works (England). Also editorial. Information concerning experience which is not encouraging. 2500 w. Eng News—Nov. 24, 1910. No. 18875.

Sewage Disposal in the Potteries. W. H. Makepeace. Explains how the sewage problem has been solved in the area known as the Potteries, in the northern part of Staffordshire, England. 8000 w. Jour Inst of San Engrs—Oct., 1910. No. 18552 B.

See also Industrial Wastes, under MUNICIPAL ENGINEERING.

Sewers.

Difficult Sewer Reconstruction in Brooklyn. An outline of the methods used in rebuilding and enlarging a sewer where conditions are difficult. Ills. 1200 w. Eng Rec—Nov. 26, 1910. No. 18953.

See also Water Works under WATER SUPPLY.

Sidewalks.

Sidewalk and Curb Grades. Clark G. Anderson. A discussion of the sidewalk question and the elements to be considered in establishing grades. 3000 w. Munic Engng—Nov., 1910. No. 18807 C.

Correlation of Sidewalk and Curb Grades. Clark G. Anderson. Read before the Am. Soc. of Munic. Imp. Discusses the elements to be considered in establishing sidewalk grades. 3500 w. Engng-Con—Nov. 9, 1910. No. 18443.

Supervision.

Supervision of Municipal Work. Will P. Blair. Read before the Am. Soc. of Munic. Imp. Critical discussion of methods. 2000 w. Munic Engng—Nov., 1910. No. 18810 C.

WATER SUPPLY.

Aqueducts.

The Esopus Cut-and-Cover Section of the Catskill Aqueduct. Illustrates and describes the traveling concrete plant used, building 60 feet of aqueduct daily. 4000 w. Eng Rec—Nov. 5, 1910. No. 18404.

Artesian.

See Irrigation, under WATER SUPPLY.

Auburn, N. Y.

The Water Supply from Owasco Lake and the Sanitary Inspection of Its Watershed. J. Walter Ackerman. Considers that absolute safety can only be secured by filtration. 2500 w. Cornell Civ Engr —Nov., 1910. No. 18828 C.

Baltimore.

See Filtration, under WATER SUPPLY.

Dams.

A Buttressed Masonry Dam Reinforced with Steel I-Beams. F. S. Tainter. Illustrated description of a dam at High Bridge, N. J. 1000 w. Eng News—Nov. 24, 1910. No. 18874.

The La Perle Dam; A 130-Ft. Hollow Reinforced-Concrete Dam Near Douglas, Wyoming. Illustrates and describes the method of construction and of securing continuity of foundation. 1500 w. Eng News—Nov. 10, 1910. No. 18448.

See also Hydro-Electric, under ELECTRICAL ENGINEERING, GENERATING STATIONS.

Filtration.

The Cleansing of Filtering Media and Materials for Constructional Work. A.

B. Ogden. Explains media which have been used for filtering. 2200 w. Jour Inst of San Engrs—Oct., 1910. No. 18550 B.

The Toledo Filtration Plant. Explains conditions and gives illustrated description of the new filter plant. 5000 w. Eng Rec—Nov. 26, 1910. No. 18952.

Experimental Filter Plant at Baltimore. Alfred M. Quick. Illustrates and describes a small plant constructed to obtain information needed for a proposed enlarged and improved supply. 1200 w. Eng Rec—Nov. 26, 1910. No. 18957.

See also Concrete, under CONSTRUCTION.

Fire Protection.

Fire Protection in the New York Station of the P. R. R. Brief description of the system installed and its interesting details. 1800 w. Ry & Engng Rev—Oct. 29, 1910. No. 18263.

Glasgow.

The Loch Arklet Extension of the Glasgow Water Supply. Describes the general scheme and the difficulties to be overcome, giving illustrated description f methods of construction. Plate. 2500 w Engr, Lond—Nov. 18, 1910. No. 18997 A.

Irrigation.

The Possibilities of Artesian Water Supplies for Irrigation in Wyoming. Eliot Blackwelder. Predicts that such supplies will soon be used. Ills. 1400 w. Wis Engr—Nov., 1910. No. 18825 C.

Irrigation in the Madras Presidency, 1908-1909. Brief editorial review of the recent report of progress, referring to the various schemes and their results. 1500 w. Engng—Nov. 11, 1910. No. 18683 A.

Pipe Calking.

Pneumatic Calking of Mains with Lead Wool. Colin C. Simpson, Jr. Abstract of a paper before the Am. Gas Inst. giving a detailed account of extensive tests and the satisfactory results. 2500 w. Eng Rec—Nov. 12, 1910. No. 18513.

Pollution.

Pollution of City Water Through Check Valves on Private Fire Protection Plants. J. Walter Ackerman. Read before the Am. Soc. of Munic. Imp. Discusses the connection of secondary supplies and the relations of the check valves, based on his experiment at Auburn, N. Y. 2500 w. Munic Engng—Nov., 1910. No. 18806 C.

Purification.

Some Notes on the History of Water Purification. Information from Messrs. Hering & Fuller's report in connection with the Montreal water supply, giving historical notes on the development of water purification. Also editorial. 7000 w. Eng Rec—Nov. 12, 1910. No. 18509.

Tanks.

Principles Involved in Tank Design. A. Gadd. The present article considers a cast iron water retainer, illustrating modern practice. 1200 w. Mech Wld—Nov. 4, 1910. Serial. 1st part. No. 18570 A.

Water Works.

Manila Water-Works and Sewer Construction. Final report of Major J. F. Case, giving illustrated description of the work. 4000 w. Far East Rev—Aug., 1910. No. 18638 N.

Weirs.

A Rolling Weir on the Trisanna (Walzenwehr an der Trisanna). Alfred Wessely. Illustarted description of an installation in Austria. 1500 w. Zeitschr d Oest Ing u Arch Ver—Oct. 7, 1910. No. 18786 D.

Wells.

Types of Wells; Their Comparative Cost and Merits and Methods of Protection from Pollution. Extract from Water Supply paper No. 255, U. S. Geol. Survey. Myron L. Fuller. Considers types, yield, safety, sources of pollution, protection, etc. Ills. 9000 w. Engng-Con—Nov. 23, 1910. No. 18889.

WATERWAYS AND HARBORS.

Barge Canal.

See Excavation, under CONSTRUCTION.

Canal Haulage.

See same title, under STREET AND ELECTRIC RAILWAYS.

Coast Erosion.

The Phenomena of the Sea, as Regards Encroachment and the Reclamation of the Coast. Frank Latham. A study of sea forces, and a description of Latham's dynamometer. 5000 w. Surveyor—Oct. 28, 1910. No. 18488 A.

Docks.

Baltimore City's New Dock System. Oscar F. Lackey. Illustrated account of the work of constructing the municipal piers; the use of concrete and steel, cost etc. 3500 w. Cornell Civ Engr—Nov., 1910. No. 18827 C.

Genoa.

Projects for the Improvement of Genoa Harbor (Il Piano regolatore del Porto di Genova). Discusses the requirements of the port and plans for its improvement. Ills. Serial. 1st part. 4000 w. Ing Ferro—Oct. 16, 1910. No. 18738 D.

Levees.

See Sacramento River, under WATERWAYS AND HARBORS.

Lighthouses.

Placing a Floating Concrete Crib for a Lighthouse. Illustrated description of methods used at Lloyd Harbor, Long Island, N. Y. 1800 w. Eng Rec—Nov. 19, 1910. No. 18662.

Aids to Navigation on the Pacific Coast. The present article deals with the waters of the coast from Puget Sound northward, including Alaska.

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3000 w. Marine Rev—Nov., 1910. Serial. 1st part. No. 18542.

Locks.

The Siphon Lock on the New York State Barge Canal at Oswego, N. Y. D. A. Watt. Illustrated description of a recently completed lock of unusual type, and its operation. 5500 w. Eng News—Nov. 17, 1910. No. 18606.

Palermo.

The Improvement of the Port of Palermo (Sulla Sistemazione del Porto di Palermo). C. Verdinois. Discusses the requirements of the port of Palermo and plans for its improvement. Ills. 7000 w. Riv Marit—Oct., 1910. No. 18731 E + F.

Panama Canal.

Progress in the Construction of the Panama Canal. Recent photographs, with abstract of the annual report. 3000 w. Engineering Magazine—Dec., 1910. No. 18943 B.

The Year's Progress on the Panama Canal. Illustrated review of the last annual report. 1200 w. Sci Am—Nov. 26, 1910. No. 18812.

The Record of a Year's Work on the Panama Canal. A summary of the report of Col. George W. Goethals for the year ending June 30, 1910, with illustrations and map. 11700 w. Eng Rec—Nov. 26. 1910. No. 18956.

Extracts from the Annual Report of the Isthmian Canal Commission for the Year Ending June 30, 1910. Illustrates and describes the design of locks and dams, and the past year's work on the Atlantic and Pacific divisions. 12500 w. Eng News—Nov. 24, 1910. No. 18872.

The Panama Excursion of the American Institute of Mining Engineers. W. L. Saunders. Also editorial. An account of the trip, and commendation of the work. 9000 w. Eng News—Nov. 24, 1910. No. 18876.

An Endorsement of the Panama Canal Work by a Party of Engineers. A testimonial from members of the Am. Inst. of Min. Engrs. who recently returned from a visit to the Isthmus. 1200 w. Eng News—Nov. 17, 1910. No. 18610.

The Panama Canal. G. H. Mee. Early plans and attempts at construction are described and also modern methods and conditions. Ills. 4000 w. Mines & Min—Nov., 1910. No. 18335 C.

Electricity and the Panama Canal. John George Leigh. Discusses points of undertaking of interest to electrical engineers, with a brief survey of the progress. Ills. 2500 w. Elec Rev, Lond—Nov. 4, 1910. Serial. 1st part. No. 18561 A.

Riparian Rights.

Riparian Boundaries. J. B. Davis. Considers their location and their survey. 11700 w. Jour Assn of Engng Socs—Oct., 1910. No. 18696 C.

River Improvement.

Cumberland River Improvements. John Leiper. Illustrated account of the locks and dams on this stream. 1700 w. Mfrs' Rec—Nov. 10, 1910. No. 18422.

River Regulation.

River Regulation under the Austrian Waterways Act (Die Flussregulierungen auf Grund des österreichischen Wasserstrassengesetzes). Hugo Franz. Discusses particularly the state of the work in Bohemia. Ills. Serial. 1st part. 7200 w. Oest Wochenschr f d Oeffent Baudienst—Oct. 15, 1910. No. 18789 D.

Sacramento River.

The Problem of the Sacramento River. H. C. Crafts. Explains the changed condition of this river, discussing the probable causes, and describing the levees constructed along the banks. Ills. 1600 w. Sci Am Sup—Nov. 19, 1910. No. 18646.

Sea Walls.

Design for a Granite Masonry Sea Wall at Boston, Mass. Sections and description of work being done by the Land and Harbor Commission of Massachusetts. 2500 w. Engng-Con—Nov. 9, 1910. No. 18444.

Subaqueous Drilling.

A Large Drill Boat. Illustrated description of drill boat used at Black Rock Harbor, Buffalo, N. Y. 350 w. Eng Rec—Nov. 26, 1910. No. 18954.

Water Powers.

Water-Power Possibilities in Southeastern Alaska. John C. Hoyt. Describes the general topographic features, the geology, climate, vegetation, industrial conditions, and power possibilities. Ills. 2500 w. Eng News—Nov. 24, 1910. No. 18871.

The Utilization of the Rhine for Power Development and Navigation (Zur Frage der Ausnutzung des Rheins für Industrie und Schiffahrt). Fr. Kretz. A review of projects for utilizing the water powers and improving the navigation. Ills. 3500 w. Die Turbine—Sept. 20, 1910. No. 18773 D.

Wharves.

A Reinforced-Concrete Wharf on the Guadalquivir, Spain (Landungssteg aus Eisenbeton am Guadalquivir, Spanien). Juan Manuel de Zafra. Describes the structure and its erection. Ills. 2700 w. Beton u Eisen—Oct. 7, 1910. No. 18795 F.

MISCELLANY.

Canada.

The Scope of Engineering in Canada. R. W. Leonard. A general talk on the engineering outlook in Canada, the opening and developing of the country, and the work that engineers must accomplish. 3000 w. Ap Sci—Nov., 1910. No. 18818 C.

Formulae.

Formulas, Their Uses and Abuses. Alfred Hume. A paper read before the Engineering Association of the South in March, 1897. 3000 w. Eng Rec—Nov. 5, 1910. No. 18406.

We supply copies of these articles. See page 670.

ELECTRICAL ENGINEERING.

COMMUNICATION.

Fault Location.

See Submarine Cables, under COMMUNICATION.

Radiotelegraphy.

The Energy Relations of Certain Detectors Used in Wireless Telegraphy. W. H. Eccles. Abstract of paper read before the Physical Society. Describes results of experiments on the properties of detectors. 1000 w. Elect'n, Lond—Nov. 11, 1910. No. 18675 A.

The Periodicities and Damping Coefficients of Coupled Oscillators. J. S. Stone. Abstract of a paper read before the Soc. of Wireless Tel. Engrs. Discusses two coupled oscillatory circuits, reacting results tending to show that some assumptions used are not founded on fact. 700 w.. Elect'n, Lond—Oct. 21, 1910. No. 18283 A.

Wireless Telegraphy and Telephony. Cornelius D. Ehret. An illustrated review of ethereal signaling methods. 4000 w. Sci Am Sup—Nov. 26, 1910. Serial. 1st part. No. 18813.

Wireless Communication as Applied to Railroad Lines. Lee de Forest. Abstract of a paper read before the Assn. of Ry. Tel. Supts. An account of experimental work and explanation of the usefulness to railroads. 2500 w. Elec Rev & W Elec—Nov. 5, 1910. No. 18388.

Submarine Cables.

By Cable to the Arctic. George E. Walsh. An account of the new cable and overland telegraph system to Nome, under the Arctic Circle. 1600 w. Sci Am Sup—Nov. 12, 1910. No. 18460.

Localizing Partial Earth Faults in Submarine Cables. Herbert E. Cann. Describes a method of using Cann's triple test as an earth overlap, illustrating by two examples. 1000 w. Elec Rev, Lond—Nov. 18, 1910. No. 18975 A.

Telegraphy.

The Practical Application of Automatic Telegraphy. Romyn Hitchcock. Abstract of a lecture briefly reviewing the history of the telegraph, and describing the Delany patents. Ills. 3300 w. Sib Jour of Engng—Oct., 1910. No. 18312 C.

Telephone Lines.

Toll-Line Location. H. D. Steele. Suggestions for location of lines and methods of construction. 2200 w. Elec Rev & W Elect'n—Nov. 12, 1910. No. 18525.

Telephone Plants.

The Telephone Plant of the New Pennsylvania Terminal. J. N. C. Graham. Illustrated description of a model equipment. 3000 w. Elec Rev & W Elect'n—Nov. 12, 1910. No. 18523.

Telephone Rates.

Is a Rational Basis Possible for Telephone Rates? Dugald C. Jackson. Read at Buffalo, N. Y., before the Nat. Munic League. Shows the complexity of the problem, and states general principles and factors to be considered. 5000 w. Can Engr—Nov. 24, 1910 No 18880

See also Rates, under GENERATING STATIONS.

Telephony.

Some Technical Features of Telephone Engineering. Abstracts of two lectures. I. Extension of Equipment. R. M. Ferris. II. Extension of the Commercial Range of Transmission. Dr. Jewett. 2800 w. Sib Jour of Engng—Oct., 1910. No. 18313 C.

Uses of the Induction Balance and Its Application in Telephony. C. A. Smith. Illustrated description of the Hughes' audiometer, explaining its usefulness for testing the hearing by doctors, or for testing telephone operators' hearing. 700 w. Elec Rev, Lond—Nov. 4, 1910. No. 18562 A.

Discussion on "Telephone Engineering Around the Golden Gate." Jefferson, N. H., June 29, 1910. Arthur Bessey Smith's paper is discussed. 2500 w. Pro Am Inst of Elec Engrs—Nov., 1910. No. 18843 F.

DISTRIBUTION.

Circuit Breakers.

Alarm-Signalling Devices for Circuit-Breakers. S. Lees. Illustrates and describes types of bell-alarm contact devices and their construction. 1000 w. Elec Rev, Lond—Oct. 21, 1910. No. 18281 A.

Earthing.

Earthing Regulations in Practice. Calls attention to the present system of earthing steel conduits in private houses, and its weakness as a protection. 1000 w. Elec Rev, Lond—Oct. 28, 1910. No. 18482 A.

Switches.

See Electric Power, under MINING AND METALLURGY, COAL AND COKE.

Wiring.

See Electric Driving, under MECHANICAL ENGINEERING, POWER AND TRANSMISSION.

DYNAMOS AND MOTORS.

A. C. Motors.

Alternating-Current Motors and Motor Service. The present number considers induction on rotary-field motors. Diagrams. 1700 w. Mech Wld—Nov. 4, 1910 Serial. 1st part. No. 18572 A.

The Calculation of the Magnetizing Current of Three-Phase Motors (Die Berechnung des Magnetisierungsstromes von Drehstrommotoren). Max Kloss. De-

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scribes a new rapid method. Ills. 4500 w. Elektrotech u Maschinenbau—Oct. 9, 1910. No. 18910 D.

The Theory of the Three-Phase Commutator Shunt Motor (Zur Theorie des Drehstromkollektor-Nebenschlussmotors). L. Dreyfus and F. Hillebrand. The first part shows the difference between the induction motor and the commutator motor, caused by the rotor stray flux in the latter machine. Ills. Serial. 1st part. 3500 w. Elektrotech u Maschinenbau. Oct. 16, 1910. No. 18912 D.

Cooling.

Radial Ventilation Slits for the Cooling of Electrical Machines (Ueber die radiale Kühlung elektrischer Maschinen). Theodore Hoock. A discussion of their effectiveness. Ills. 1700 w. Elektrotech u Maschinenbau—Oct. 23, 1910. No. 18911 D.

D. C. Generators.

Switching Phenomena in Self-Exciting Direct-Current Machines (Einschaltvorgänge bei selbsterregenden Gleichstrommaschinen). A. Schwaiger. Gives a graphical method of analyzing circuit-making problems. Ills. 2000 w. Elektrotech u Maschinenbau—Oct. 30, 1910. No. 18913 D.

Foundations.

Construction of Foundations for Electrical Machinery. Bruce H. Page. Illustrated discussion of types of concrete foundations. 1000 w. Elec Wld—Nov. 3, 1910. No. 18343.

Induction Motors.

Squirrel Cage Induction Motors with High Resistance Secondaries. Rudolph E. Hellmund. Discusses features to be considered in connection with their application. 4500 w. Elec Jour—Nov, 1910. No. 18803.

The Irregularities in the Rotating Field of the Polyphase Induction Motor. Charles F. Smith. An experimental study of the causes. Ills. 3500 w. Mech Engr—Nov. 18, 1910. Serial. 1st part. No. 18985 A.

Grounds and Overloads on Induction Motors. R. H. Fenkhausen. Shows where grounds may occur and discusses their effects. Also tells how to prevent overloads. 1800 w. Power—Nov. 15, 1910. No. 18532.

Direct-Current Braking of Induction Motors (Bremsen von Induktionsmotoren mittels Gleichstrom). R. E. Hellmund. A theoretical discussion. Ills. 2300 w. Elektrotech u Maschinenbau—Oct. 2, 1910. No. 18908 D.

Starters.

Induction Motor Hand Starters. R. H. Fenkhausen. Illustrated explanation of the construction and operation of the principal types. 1500 w. Power—Nov. 1, 1910. Serial. 1st part. No. 18269.

The Graphical Calculation of the Starting Resistance of Shunt-Wound Motors (Ein Beitrag zur graphischen Berechnung der Anlasswiderstände für Nebenschlussmotoren). Robert Edler. Mathematical demonstration of a method of calculating the different steps. Ills. 2000 w. Elektrotech u Maschinenbau—Oct. 2, 1910. No. 18909 D.

ELECTRO-CHEMISTRY.

Cells.

The Cathode Equilibrium in the Weston Standard Cell. G. A. Hulett. Abbreviated from the *Phys. Rev.* An experimental study in connection with the hydrolysis of mercurous sulphate by the cadmium sulphate solution in Weston cells. 1800 w. Elect'n, Lond—Oct. 21, 1910. No. 18287 A.

Corrosion.

Corrosion. Notes from Mr. Stromeyer's annual report to the Manchester Steam Users' Assn. 2000 w. Engr, Lond—Nov. 18, 1910. No. 19000 A.

Electric Furnaces.

The Electric Furnace and Its Use. Henry M. Lane. Briefly considers various types adapted to special uses. Ills. 3000 w. Jour Cleveland Engng Soc—Sept., 1910. No. 18272 D.

Data on an Electrical Resistance Furnace. Albert A. Somerville. Describes the furnace and method of control. 700 w. Elec Wld—Nov. 17, 1910. No. 18597.

Norwegian Electric Furnaces. Describes experience with a Hiorth installation for steel production, and the construction of the Soderberg electric induction furnace. Ills. 1200 w. Ir Age—Nov. 24, 1910. No. 18856.

The Frick Electric Reduction Furnace. Dr. Eugene Haanel. Abstract from Bul. No. 3, Canada Dept. of Mines. The largest example of the electric smelting furnace with comparative costs of operation. 4500 w. Ir Trd Rev—Nov. 3, 1910. No. 18355.

Electrolytic Assaying.

Rapid Electrolytic Method of Analysis. R. C. Benner. Explains the principle and apparatus devised to apply it. 1200 w. Min & Sci Pr—Oct. 29, 1910. No. 18366.

Electrometallurgy.

See same title, under MINING AND METALLURGY, IRON AND STEEL; and Silicon, under MINING AND METALLURGY, MINOR MINERALS.

Electroplating.

See Accumulators, under GENERATING STATIONS.

Nitrogen.

The Equilibrium of the System Consisting of Calcium Carbide, Calcium Cyanamide, Carbon and Nitrogen. M. de Kay Thompson and Robert H. Lombard. Report of research work on the fixation of atmospheric nitrogen, describing the method of carrying out the experiments. 2000 w. Met & Chem Engng—Nov., 1910. Serial. 1st part. No. 18440 C.

We supply copies of these articles. See page 670.

ELECTRO-PHYSICS.

Alternating Currents.

Discussion on "Victor Power in Alternating-Current Circuits." Jefferson, N. H., June 29, 1910. The paper by A. E. Kennelly is discussed. 4500 w. Pro Am Inst of Elec Engrs—Nov., 1910. No. 18851 F.

Dielectrics.

See Insulating Materials, under MISCELLANY.

Electromagnets.

Electromagnets (Ueber Elektromagnete). E. Jasse. A detailed review of the theory and design of electromagnets. Ills. Serial. 1st part. 3800 w. Elektrotech u Maschinenbau—Oct. 2, 1910. No. 18907 D.

Induction Coils.

Some Observations on the Action of the Condenser in a Ruhmkorff Induction Coil. Dr. J. W. Waghorn. Describes experiments made to determine what oscillations are set up in the condenser. 3500 w. Elect'n, Lond—Nov. 11, 1910. No. 18676 A.

Radioactivity.

Recent Study of Radium. F. Henrich. Condensed from *Zeit. f. any. Chemic.* A review of recent progress and new research work in the field of radioactivity. 4500 w. Sci Am Sup—Nov. 12, 1910. No. 18463.

The Theory of Radioactive Phenomena (Die Theorie der radioaktiven Erscheinungen). Clemens Schaefer. A review of recent research and progress in this branch of electro-physics. Ills. 7150 w. Zeitschr d Ver Deutscher Ing—Oct. 8, 1910. No. 18921 D.

GENERATING STATIONS.

Accumulators.

Some Recent Problems in Storage Battery Engineering. Joseph Appleton. Considers its application in various power plants, representing results of efficiency. 4000 w. Jour Fr Inst—Nov., 1910. No. 18697 D.

The New Edison Storage Battery and the Part that Electroplating Plays in Its Manufacture. The battery and methods of manufacture are described in detail. Ills. 1000 w. Brass Wld—Nov., 1910. No. 18625.

The 1910 Edison Storage Battery. Walter E. Holland. Read before the Assn. of Edison Ill. Co.'s. Gives results of tests and details of testing, ratings, endurance, etc. 2000 w. Elect'n, Lond—Oct. 21, 1910. Serial. 1st part. No. 18284 A.

Auxiliary Plants.

Discussion on "Emergency Generating Stations for Service in Connection with Hydroelectric Transmission Plants Under Pacific Coast Conditions." San Francisco, Cal., May 7, 1910. A. M. Hunt's paper is discussed. 8500 w. Pro Am Inst of Elec Engrs—Nov., 1910. No. 18842 F.

Centralization.

The Electrification of a Commonwealth. Sylvester Baxter. Discusses the economies of centralized power supply and public utility operation as exemplified in the State of Connecticut. 3500 w. Engineering Magazine—Dec., 1910. No. 18939 B.

Central Stations.

Interconnected Massachusetts Generating Plants. Illustrates and describes the system and operating features of the Greenfield Electric Light & Power Company. 3500 w. Elec Wld—Nov. 3, 1910. No. 18341.

Central Station at Newcastle, Ind. Osborn Monnett. Illustrated description of the mechanical equipment of a small central power and heating station. 1200 w. Power—Nov. 8, 1910. No. 18432.

New Reading Central Station. Illustrated description of this new generating station in connection with the reconstruction of the system of the Metropolitan Electric Co. 2 plates. 4500 w. Eng Rec—Nov. 19, 1910. No. 18666.

Electric Generating and Distributing System in Reading, Pa. Describes the combined lighting and railway equipment of the Metropolitan Electric Co. Ills. 2500 w. Elec Wld—Nov. 17, 1910. No. 18594.

New Power Generating and Distributing System in Reading, Pa. Illustrates and describes a reconstructed power system for increasing the sale of energy and securing economy. A number of unusual features were introduced. 5500 w. Elec Ry Jour—Nov. 19, 1910. No. 18633.

A New Power Scheme for the General Post-Office. A new scheme embracing a main generating station and three substations, is illustrated and described. 3000 w. Engr, Lond—Nov. 18, 1910. Serial. 1st part. No. 18999 A.

The General Post-Office Power Supply. Illustrated description of the new scheme of supply recently put in operation. 2000 w. Elec Rev, Lond—Nov. 18, 1910. Serial. 1st part. No. 18974 A.

Electric Power Supply on the North-East Coast. Illustrates and describes stations utilizing waste heat and gas. 2800 w. Ir & Coal Trds Rev—Nov. 4, 1910. Serial. 1st part. No. 18500 A.

Depreciation.

See same title, under INDUSTRIAL ECONOMY.

Diversity Factor.

Diversity Factor in the Distribution of Electric Light and Power. H. B. Gear. Gives an analysis of the diversity between the various elements of a distribution system and derives the total diversity factor for various classes of business. Discussion. 5000 w. Jour W Soc of Engrs—Oct., 1910. No. 18831 D.

Economics.

Central Station Service. H. R. Leonard. Suggestions for satisfactory service from

the commercial standpoint. 1500 w. Elec Rev & W Elect'n—Nov. 12, 1910. No. 18524.

Address of Mr. M. J. Railing to the Birmingham Local Section of the I. E. E. (Abstract). The writer's views on the present position of the electrical industries in England. 2500 w. Elect'n, Lond—Nov. 18, 1910. No. 18977 A.

Address of Mr. T. Harding Churton to the Yorkshire Local Section of the I. E. E. (Abstract). Discusses conditions in England affecting the electrical industries, and the duty of promoting the development of electricity. 2200 w. Elect'n, Lond—Nov. 18, 1910. No. 18978 A.

The Production and Sale of Electrical Energy (Consideraciones generales sobre la Produccion y la Venta de la Energia electrica). Luis Brandon. A general discussion of the economics of central-station management. Serial. 1st part. 1700 w. Energia Elec—Oct. 25, 1910. No. 18742 D.

See also Systems, under STREET AND ELECTRIC RAILWAYS.

England.

See Economics, under GENERATING STATIONS.

Hydroelectric.

Impressions of Recent Hydroelectric Practice in Switzerland. W. F. Durand. Gives results of observations made during the past summer, as shown by the more recent plants in operation and some notable plants under construction. Ills. 3000 w. Eng Rec—Nov. 12, 1910. No. 18508.

Electric Power at Madrid (Transporte de Fuerza a Madrid). Rafael Torres Marino. Describes the Molinar hydro-electric station. Ills. Serial. 1st part. 1800 w. Energia Elec—Oct. 10, 1910. No. 18741 D.

The Tuilière Dam and Hydro-Electric Plant (Le Barrage et l'Usine hydro-électrique de Tuilière). A Claveille. A detailed description of this important plant on the Dordogne, in Southwest France. Ills. Plates. Serial. 1st part. 3000 w. Tech Mod—Oct., 1910. No. 18713 D.

A Project for a Hydro-Electric Plant on the Murg above Forbach (Entwurf eines Wasserkraftwerkes im Gebiet der Murg oberhalb Forbach). Theodor Koehn. A review of a second edition of a book by Professor Rehbock, advocating the erection of a large power house at this point in Bavaria. Ills. 3600 w. Die Turbine—Sept. 20, 1910. No. 18774 D.

Hydro-Electric Plants on the Poglia and its Tributaries of the Adamello Electric Company (Gli Impianti idro-elettrici del Poglia e suoi Affluenti nell'Alta Valle Camonica della Societa Generale Elettrica dell'Adamello). Describes a system of power plants in Northern Italy. Ills. Serial. 1st part. 2700 w. Monit Tech—Sept. 30, 1910. No. 18732 D.

The High Falls Development of the Peshtigo River in Northern Wisconsin. Illustrated detailed description of the dams and hydraulic works, power house, transmission line, etc. 3000 w. Elec Wld—Nov. 24, 1910. No. 18892.

Yngeredsfors Power Plant and 40,000-Volt Transmission Line to Varberg and Mölndal-Gothenburg (Sweden). Henry Chervet. Illustrated detailed description of a power installation on the Atran river. 3000 w. Elect'n, Lond—Oct. 28, 1910. Serial. 1st part. No. 18484 A.

See also Turbine Plants, under MECHANICAL ENGINEERING, HYDRAULIC MACHINERY.

Isolated Plants.

Heat, Light and Power in Buildings. C. M. Ripley. Shows the operating costs by the year of isolated plants in various types of buildings. 4500 w. Heat & Vent Mag—Nov., 1910. No. 18815.

The Central Station Point of View. E. F. Tweedy. Gives an analysis of the figures given by C. M. Ripley from the central station viewpoint. 2000 w. Heat & Vent Mag—Nov., 1910. No. 18816.

Electric Equipment of King Edward Building. Illustrated description of the scheme of electrical illumination and electric power equipment of this London building. 3000 w. Elect'n, Lond—Nov. 18, 1910. No. 18976 A.

A New Generating Plant at a Technical School. Illustrated description of the plant installed at the Northampton Polytechnic Institute, Clerkenwell. 2200 w. Engr, Lond—Oct. 21, 1910. No. 18304 A.

See also Condensers, under MECHANICAL ENGINEERING, STEAM ENGINEERING.

Rates.

Telephone and Other Electric Rate-Making. Benjamin Baker. Discusses the needed readjustment of rates, referring to the rate situation in Boston. 1700 w. Elec Rev & W Elect'n—Nov. 12, 1910. No 18526.

Switchgear.

Discussion on "The Modern Oil Switch with Special Reference to Systems of Moderate Voltage and Large Ampere Capacity. Jefferson, N. H., June 28, 1910. The paper by A. R. Cheyney is discussed. 6500 w. Pro Am Inst of Elec Engrs—Nov., 1910. No. 18845 F.

LIGHTING.

Illumination.

The New Era in Electrical Illumination. Rollin W. Hutchinson, Jr. An illustrated review of the new systems, discussing metal-filament lamps in the present article. 6500 w. Engineering Magazine—Dec., 1910. Serial. 1st part. No. 18942 B.

Incandescent Lamps.

Effects of the Form of Electromotive Force Waves Upon the Life and Effi-

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ciency of Incandescent Lamps. An account of tests made by Prof. Charles L. Kinsloe, with editorial comment on results. 2000 w. Elec Wld—Nov. 17, 1910. No. 18596.

The Development of the One-Watt Metal Lamp in the Last Two Years. Hartwig von Loti. Abstract of a lecture before the Elektrotechnische Verein in Vienna. 600 w. Elect'n, Lond—Nov. 4, 1910. No. 18563 A.

See also Illumination, under LIGHTING.

Photometry.

Surface Brightness. J. S. Dow and V. H. Mackinney. Abstract of paper read before the Optical Soc., London. Illustrates a new instrument for its measurement—the "Lumeter" photometer. 3500 w. Elec Engr, Lond—Oct. 21, and 28, 1910. 2 parts. No. 18479 each A.

Train.

See Train Lighting, under RAILWAY ENGINEERING, MOTIVE POWER AND EQUIPMENT.

Vacuum Tubes.

Vacuum-Tube Lighting. D. McFarlan Moore. Refers to investigations and results obtained by the author. 1500 w. Jour Fr Inst—Nov., 1910. No. 18800 D.

MEASUREMENT.

Alternating Current.

Discussion on "Some Recent Developments in Exact Alternating Current Measurements." Jefferson, N. H., July 1, 1910. The paper by Clayton A. Sharp and William W. Crawford is discussed. 4000 w Pro Am Inst of Elec Engrs—Nov., 1910. No. 18847 F.

Frequency Meters.

Non-Vibratory Types of Frequency Meters. C. E. Hiatt. Abstract of an article in the *Phys. Rev.* Describes a modification of this instrument for the purpose of frequency determination and gives an account of its performance. Also discusses a bolometric frequency meter devised by the author. 800 w. Elect'n, Lond—Nov. 18, 1910. No. 18980 A.

Inductive Balances.

See Telephony, under COMMUNICATION.

Laboratories.

The Electrical Laboratory of the Berlin Technical High School (Das elektrotechnischen Versuchsfeld der Technischen Hochschule zu Berlin). W. Reichel and M. Gerstmeyer. Describes the addition built in 1907. Ills. 1700 w. Elek Kraft u Bahnen—Oct. 4, 1910. No. 18904 D.

Potentiometers.

A Remarkable Vector Diagram. Henry Tinsley. A complicated vector diagram is given showing the accuracy to which the phase differences and magnitudes of a. c. in complex circuits can be measured by Dr. C. V. Drysdale's a. c. potentiometer. 1400 w. Elect'n, Lond—Nov. 18, 1910. No. 18979 A.

POWER APPLICATIONS.

Agriculture.

Electric Plowing on the Two-Machine System (Der Elektropflug nach dem Zweimaschinensystem). K. Porsch. Describes the apparatus for plowing by means of winding motors placed at either end of the furrow. Ills. 2000 w. Elek Kraft u Bahnen—Oct. 4, 1910. No. 18903 D.

Panama Canal.

See same title, under CIVIL ENGINEERING, WATERWAYS AND HARBORS.

Pumping.

See Electric Pumping, and Pumping Plants, under MECHANICAL ENGINEERING, HYDRAULIC MACHINERY.

Shovels.

Electrically Operated Shovels. W. H. Patterson. Illustrates and describes the mechanical equipment, giving operating costs. 1200 w. Elec Jour—Nov., 1910. No. 18801.

TRANSMISSION.

Insulators.

Electrostatic Limits in High-Tension Transmission-Line Insulators. Explains the condenser effects in insulators, and the advantages secured by the invention of the suspension type of insulator. 1200 w. Elec Wld—Nov. 10, 1910. No. 18447

Line Reconstruction.

Reconstruction Work in Salt Lake City. Illustrates and describes improvements and addition to the system of the Utah Light & Railway Company. 5000 w. Elec Wld—Nov. 10, 1910. No. 18445.

Lines.

Discussion on "The Developed High Tension Net Work of a General Power System," San Francisco, Cal., May 5, 1910. Discussion on Paul M. Downing's paper. 4000 w. Pro Am Inst of Elec Engrs—Nov., 1910. No. 18840 F.

Monocyclic System.

The Monocyclic System of Distribution for Small Central Stations (Distributions monocycliques pour petites Stations centrales). A. R. Garnier. Describes the system and briefly discusses its advantages. Ills. 1500 w. L'Elecn—Oct. 8, 1910. No. 18716 D.

Poles.

The Calculation and Testing of Siegwart Concrete Poles (Versuche und Berechnung von Siegwartmasten). F. Steiner. Mathematical demonstration of the method of designing and testing concrete poles for electrical transmission lines. Ills. 2000 w. Beton u Eisen—Oct. 7, 1910. No. 18794 F.

Protective Devices.

The Development of Protective Devices for High-Tension Circuits. P. G. Langley. Illustrates and describes types of switching, measuring, and protective equipment. 1800 w. Elec Rev & W Elect'n—Nov. 26, 1910. No. 18861.

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Rotary Condensers.

Power-Factor and Rotary Condensers. L. S. Thurston. Explains the advantages of "rotary condensers" in connection with a system of low power-factor. 1500 w. Elec Wld—Nov. 10, 1910. No. 18446.

Rotary Converters.

Voltage Regulation of Compound Wound Rotary Converters. Jens Bache-Wiig. Explains method of operating and of predetermining the voltage characteristic. 2500 w. Elec Jour—Nov., 1910. No. 18802.

Interpoles in Synchronous Converters. B. G. Lamme and F. D. Newbury. A partial analysis of the conditions occurring in synchronous converters and in direct-current generating, indicating wherein interpoles are of greater advantage on d. c. generators than on converters. 11500 w. Pro Am Inst of Elec Engrs—Nov., 1910. No. 18854 F.

Short Circuits.

Short Circuits in A. C. Transmission Networks, their Effect on Generators, Especially Turbo-Dynamos, and Methods of Protection (Kurzschlüsse in Wechselstromnetzen, ihre Rückwirkung auf die Generatoren, insbesondere bei Turbodynamos, und Mittel zur Verhütung dadurch bedingeter Beschädigungen). Gustav W. Meyer. The first part discusses their effect on the stator windings of turbo-dynamos. Ills. Serial. 1st part. 3500 w. Elektrotech Rundschau—Oct. 20, 1910. No. 18902 D.

Transformers.

Discussion on "Determination of Transformer Regulation Under Load Conditions and Some Resulting Investigations. Jefferson, N. H., June 29, 1910. The paper by Adolph Shane is discussed. 3000 w. Pro Am Inst of Elec Engrs—Nov., 1910. No. 18848 F.

Voltage.

Limiting Voltages on Transmission Lines. Erich Hausmann. Considers the critical voltages between conductors, depending on the diameter and spacing. 600 w. Elec Wld—Nov. 17, 1910. No. 18595.

Voltage Regulation.

Some Types of Circuits for Voltage, Current and Power Control. Clarence I. Zimmerman. A diagrammatic study of step-by-step transformer regulators is given in the present article. 2500 w. Elec Rev & W Elect'n—Nov. 19, 1910. Serial. 1st part. No. 18653.

MISCELLANY.

Economics.

Inaugural Address—Institution of Electrical Engineers. S. Z. de Ferranti. (Abstract). Discusses coal conservation, home grown food, and better utilization of labor, and the benefits to be expected from cheap electric power. 7500 w. Elec. Engr, Lond—Nov. 18, 1910. No. 18972 A.

Edison.

The Patents of Thomas Alva Edison. Joseph J. O'Brien. A general review of Edison's work. 1200 w. Elec Wld—Nov. 3, 1910. No. 18340.

Fire Alarms.

A Photo-Electric Burglary and Fire Alarm. Dr. Alfred Gradenwitz. Brief description of a novel alarm, invented by M. E. Defan, based on the properties of selenium under the influence of light. 700 w. Elec Rev, Lond—Nov. 18, 1910. No. 18973 A.

Insulating Materials.

Disruptive Strength with Transient Voltages. J. L. R. Hayden and Charles P. Steinmetz. An addition to an earlier paper on this subject, by the authors. 500 w. Pro Am Inst of Elec Engrs—Nov., 1910. No. 18853 F.

Discussion on "Disruptive Strength with Transient Voltages," "The Electric Strength of Air," and "Dielectric Strength of Oil.' Jefferson, N. H., June 29, 1910. Papers by Joseph L. R. Hayden and Charles P. Steinmetz, by J. B. Whitehead and by H. W. Tobey are discussed. 11000 w. Pro Am Inst of Elec Engrs—Nov., 1910. No. 18852 F.

The Inexactitudes of Oil Testing. Wilfred Yorke. Points out the fallacies of some of the required tests and states a series of tests he considers more acceptable. 2500 w. Elec Rev, Lond—Oct. 21, 1910. No. 18282 A.

A Chemical Specification for Rubber Covered Wires and Cables. C. R. Boggs. Gives a schedule of chemical tests found useful in Germany. 1600 w. Elec Wld—Nov. 24, 1910. No. 18894.

The Dielectric Properties of Air and its Use as an Insulating Material (Propriétés diélectriques de l'Air: son Emploi comme Isolant électrique). Jean Escard. Discusses the factors influencing the dielectric strength of air and gives examples of its use as an insulator. Ills. 4800 w. Rev Gen d Sci—Oct. 15, 1910. No. 18706 D.

Projection Apparatus.

Electrical Projection Experiments. Sydney Whetmore Ashe. Illustrates and describes various projecting instruments and projection experiments. 1200 w. Sci Am—Nov. 5, 1910. Serial. 1st part. No. 18383.

United States.

Electrical Progress in the United States. J. S. Peck. Abstract of the chairman's address before the Manchester Sec. of the Inst. of Elec Engrs. Notes on observations during a recent visit on certain lines of electrical work. 4500 w. Mech Engr—Nov. 11, 1910. No. 18679 A.

Wire Splicing.

Some Tests on Splices in Galvanized Iron Wire. C. T. Rashman. Reports results of a series of tensile tests made on all of the commonly used types. Ills. 900 w. Elec Wld—Nov. 17, 1910. No. 18598.

We supply copies of these articles. See page 670.

INDUSTRIAL ECONOMY.

Accounting.

Cost Accounting. John R. Wildman. Discusses the nature of the information sought, the means of obtaining it, and the use to which the information is to be applied, explaining the accounting cost system. 2000 w. Jour of Acc—Nov., 1910 Serial. 1st part. No. 18547 C.

Apprenticeship.

A German Apprentice School. Otto Stolzenberg. Illustrated account of the methods followed. 2500 w. Am Mach—Vol. 33. No. 44. No. 18419.

See also Education, under INDUSTRIAL ECONOMY.

Conservation.

The Conservation Movement. C. W. Hayes. Outlines the trend of the movement, indicating some of the means through which the desired results must be attained. 5000 w. Min & Sci Pr—Nov. 19, 1910. No. 18937.

Cost Systems.

The Importance of Accurate Costs. Holden A. Evans. Aims to show the value of accurate cost-keeping. 3000 w. Am Mach—Vol. 33. No. 45. Serial. 1st part. No. 18472.

Depreciation.

Depreciation and Reserve Funds of Electrical Properties William B. Jackson. Discusses methods of estimating the amount to be charged for depreciation and reserve fund and how the principles should be applied. Discussion. 14000 w. Jour W Soc of Engrs—Oct., 1910. No. 18832 D.

Education.

Industrial Schools and Apprenticeship. Dexter S. Kimball. Discusses industrial education and the training needed. 5000 w. Am Mach—Vol. 33. No. 47. No. 18864.

Practical Education. W. O. Webber Considers defects in modern technical training. 2500 w. Cassier's Mag—Nov., 1910. No. 18616 B.

The Westphalian Mine-Owners Association and Miners' School. Editorial account of the work and methods. 2200 w. Engng—Nov. 18, 1910. No. 18993 A.

The International Congress on Technical Education (Le Congrès international de l'Enseignement technique supérieur). Maurice Bellom. A review of the proceedings of the Congress held in connection with the Brussels Exposition. 3000 w. Génie Civil—Oct. 8, 1910. No. 18722 D.

Engineering.

Presidential Address of Alexander Siemens before the Institution of Civil Engineers. Reviews the history of knowledge from the prosperous period of Greece to the present time, claiming progress is due principally to engineers, and outlining lines of work for further effort. Also editorial. 8500 w. Engng—Nov. 4, 1910. No. 18577 A.

Estimating.

The Elements of Engineering Estimating. A. Suggate. The present number explains the meaning of a cost-estimate. 1200 w. Prac Engr—Nov. 11, 1910. Serial. 1st part. No. 18677 A.

The Oversight and Control of Estimates (Kalkulationskritik und Kalkulationskontrolle). C. M. Lewin. A discussion of the elements which should enter into a cost estimate. 5000 w. Zeitschr f Werkzeug—Oct. 5, 1910. No. 18783 D.

Industrial Accidents.

Safeguarding Against Accidents. Thomas D. West. Read before the Cleveland Supts. & Foremen's Club. Recommends the organization of anti-accident boards, and discusses employer's liability. 3000 w. Ir Trd Rev—Nov. 24, 1910. No. 18879.

Industrial Betterment.

The Betterment of Labor Conditions in the Steel Industry. William B. Dickson. Read before the Am. Ir. & Steel Inst. Deals with accident prevention, relief and pension funds, and the reduction of Sunday labor. 4500 w. Ir Age—Nov. 3, 1910. No. 18323.

Labor.

The Conservation of Labor. Editorial on the conditions of the laboring classes in England, Germany and the United States. 1800 w. Eng News—Nov. 3, 1910. No. 18353.

Collective Agreements between Employers and Workpeople. Information from a report of the Labor Dept. of the Board of Trade, concerning wages, overtime work, youthful labor, arbitration, etc. 2500 w. Ir & Coal Trds Rev—Nov. 4, 1910. Serial. 1st part. No. 18589 A.

See also Shipbuilding, under MARINE AND NAVAL ENGINEERING.

Management.

The Twelve Principles of Efficiency. Harrington Emerson. Seventh article of a series, discussing the fifth principle—the fair deal. 5500 w. Engineering Magazine—Dec., 1910. No. 18946 B.

Systematic Foundry Operation and Foundry Costs. C. E. Knoeppel. The principal elements in foundry accounting and management are discussed in this third article of a series. 5000 w. Engineering Magazine—Dec., 1910. No. 18944 B.

Modern Factory Organization. (Moderne Organisation im Fabrikbetriebe). C. Redtmann. A discussion of German practice in works management. Ills. Serial. 1st part. 1800 w. Zeitschr f Werkzeug—Oct. 5, 1910. No. 18784 D.

We supply copies of these articles. See page 670.

Factory Organization (Organisation der Fabrikverwaltung). Martin H. Blancke. A discussion of organization for economical production. Serial. 1st part. 1800 w. Elektrotech Rundschau—Oct. 6, 1910. No. 18900 D.

Technical Requisites for Mass Production (Technische Erfordernisse für Massenfabrikation). F. Neuhaus. The first part discusses estimating, the production of drawings, standardization of parts, etc. Ills. Serial. 1st part. Tech u Wirt—Oct., 1910. No. 18931 D.

See also Shops, under MECHANICAL ENGINEERING, MACHINE WORKS AND FOUNDRIES.

Profit Sharing.

Co-Partnership between Employers and Employees in the Shipbuilding Industry (Co-Partnerschaftsversuche zwischen Arbeitnehmer und Arbeitgeber in der Schiffbau-Industrie). Herman Doerwaldt. A discussion of the labor problem in the shipbuilding industry and the experiment of Sir C. Furness. 2500 w. Schiffbau—Oct. 12, 1910. No. 18767 D.

Strikes.

Labor on the French Railways. Editorial discussion of the recent strike and its causes. 2500 w. Engng—Oct. 21, 1910. No. 18344 A.

Wage Systems.

The Pioneer in Introducing General Piece-Work. Reviews the B. & O.'s experiment of 20 years ago, in which every operation in the mechanical department had its price. 2000 w. Am Engr & R R Jour—Nov., 1910. No. 18425 C.

MARINE AND NAVAL ENGINEERING.

Battleships.

Four Recent Types of "Dreadnoughts" (Quattro Tipi recenti di "Dreadnoughts"). Luigi Barberis. A discussion of recent additions to the battleship fleets of Russia, United States, France and Argentina. Ills. 7500 w. Riv Marit—Oct., 1910. No. 18730 E + F.

Broadside Fire and List (Breitseitfeuer und Krängung). M. Weitbrecht. A mathematical discussion of the list of vessels after a broadside. Ills. 2300 w. Schiffbau—Oct. 26, 1910. No. 18768 D.

Cruisers.

Large German Cruisers. Illustrations and critical discussion of the "Von der Tann" and the "Blucher." 2500 w. Engr, Lond—Nov. 4, 1910. No. 18579 A.

Destroyers.

See Ship Speed, under MARINE AND NAVAL ENGINEERING.

Explosives.

Smokeless Powder. Brief discussion of the recent accident on the U. S. battleship Georgia, the bursting of a 12-in gun, and the use of multiple-perforated powder. 2000 w. Engng—Oct. 21, 1910. No. 18295 A.

Gun Boats.

Shallow Draft Gun Boat. Illustrated description of a new gunboat for Macao, a province in one of the Portugese colonies in China, which is to be used for revenue service. 500 w. Int Marine Engng—Nov., 1910. No. 18390 C.

Hydroplanes.

The Forlanini Hydroplane (L'Idroplano Forlanini). Describes the design of this new hydroplane, and the recent trials on Lake Maggiore. Ills. 2000 w. Industria—Oct. 16, 1910. No. 18735 D.

Launching.

See Steamships, under MARINE AND NAVAL ENGINEERING.

Motor Boats.

Motor Boat Propulsion. The first of a series of articles making a study of this subject. 3000 w. Engr, Lond—Oct. 28, 1910. Serial. 1st part. No. 18500 A.

Navy Yards.

How the Meyer System of Navy Yard Organization Works. A critical discussion of naval inefficiency. 3000 w. Marine Rev—Nov., 1910. No. 18543.

Organization of a Navy Yard Sail Loft and Flag Shop. Holden A. Evans. Describes the organization of these two shops, which has given excellent results. Ills. 2500 w. Marine Rev—Nov., 1910. No. 18541.

The Naval Yard at the Cape of Good Hope. Illustrated detailed description of the recently completed yard at Simon's Town, S. Africa, and the construction work. Plates. 6500 w. Engng—Oct. 28, 1910. Serial. 1st part. No. 18495 A.

Oil Engines.

The Oil Engine in Marine Work. Editorial on the possibilities of the oil engine for ship propulsion. 2500 w. Engr, Lond—Nov. 4, 1910. No. 18584 A.

Oil-Motors for Fishing-Boats. Editorial review of the exhibition at Yarmouth, 1800 w. Engng—Nov. 4, 1910. No. 18575 A.

The North Sea Fisheries and Fishing Exhibition. Reviews the field covered by the exhibition at Yarmouth, as introductory to a detailed description of the exhibits. 2000 w. Engr, Lond—Nov. 4, 1910. Serial. 1st part. No. 18583 A.

Marine Oil Engine; North Sea Fisheries Exhibition, Great Yarmouth. Illustrated description of an engine shown by John I. Thornycroft and Co., Ltd. 1000 w. Engng—Oct. 28, 1910. No. 18499 A.

A Reversing Sulzer-Diesel Marine Oil Engine (Umsteuerbarer Sulzer-Diesel-

We supply copies of these articles. See page 670.

Schiffsmotor). Describes the installation in the passenger vessel "Uto" on the Lake of Zürich. Ills. 1600 w. Schweiz Bau—Oct. 22, 1910. No. 18771 B.

Propulsion.

The Propulsion of Ships. John Batey. Gives data for computations of speed, capacity, and powering, based on experiments made by Colonel Rota, in the Italian testing tank. 2000 w. Cassier's Mag—Nov., 1910. No. 18617 B.

Shipbuilding.

Rules for Shipbuilding. Arthur R. Liddell. Reviews recent progress which has made necessary a revision. 2500 w. Engr, Lond—Oct. 21, 1910. No. 18298 A.

The Labor Crisis in British Shipbuilding. Benjamin Taylor. Discusses the fundamental causes of the lockout. 3500 w. Cassier's Mag—Nov., 1910. No. 18615 B.

See also Navy Yards, under MARINE AND NAVAL ENGINEERING.

Ship Speed.

The Influence of Depth on Speed of French Destroyers. Discusses the subject from the observations of recent trials of the French destroyer Tirailleur. Gives analysis of trials. 2800 w. Engr, Lond—Oct. 21, 1910. No. 18297 A.

Steamboats.

Notes on American River Steamboat Practice. T. M. Rees. Information regarding the size of steamboats, tow boats, and barges used on the western rivers of the United States, and matters relating to their building and handling. 2500 w. Int Marine Engng—Nov., 1910. No. 18391 C.

A Proposed Design for a Stern-Wheel River Steamer. Illustrated description of the steamer "John Todd." 800 w. Int Marine Engng—Nov., 1910. No. 18397 C.

Stern Wheel Steamer *Endeavor* for the Congo Mission of the Baptist Missionary Society. Illustrated description of a vessel built in England for service in Africa. 1500 w. Int Marine Engng—Nov., 1910. No. 18398 C.

Stern Wheel Steamers on German Rivers. Illustrates and describes types of vessel in use. 2200 w. Int Marine Engng—Nov., 1910. No. 18393 C.

Shallow Draft Boats in the Pacific Northwest. Illustrates and describes boats used extensively in Alaskan rivers. 1000 w. Int Marine Engng—Nov., 1910. No 18399 C.

Some Data on Paddle-Wheel Steamers. Claude A. Anderson. Reliable information concerning the best marine practice, both foreign and American. 3000 w. Int Marine Engng—Nov., 1910. No. 18392 C.

The Mackenzie River. Illustrated description of a stern paddle-wheel vessel built for the far northwestern part of the North American Continent, and the difficulties met in transporting the machinery and parts of the boat. 1500 w. Int Marine Engng—Nov., 1910. No. 18395 C.

Twin Screw Tunnel Steamers vs. Stern-Wheelers for Service on the Western Rivers. Charles E. Ward. Illustrates and describes the twin-screw tunnel steamer "A. M. Scott," designed to meet conditions on the western rivers of the United States. 1800 w. Int Marine Engng—Nov., 1910. No. 18394 C.

Steam Engines.

See Superheating, under MECHANICAL ENGINEERING, STEAM ENGINEERING.

Steamships.

The Launch of the Olympic. Additional illustrations of this large vessel and description of the launching arrangements. Plate. 800 w. Engr, Lond—Oct. 28, 1910. No. 18503 A.

New Freight Steamships for the Southern Pacific Co. Illustrated description of S.S. El Mundo, the first of four freight steamships for service between New York and Galveston, Texas. 2500 w. Marine Rev—Nov., 1910. No. 18540.

A European Iron Ore Carrying Steamer. Illustrated description of the Swedish steamer, Sir Ernest Cassel, designed to discharge cargo independent of shore equipment. 2000 w. Ir Trd Rev—Nov. 24, 1910. No. 18878.

MECHANICAL ENGINEERING.

AERONAUTICS.

Aeroplane Carriages.

An Improved Wheeled Carriage for Flying Machines. Describes a combination of skids and a skid framework of a wheel chassis. Ills. 1500 w. Prac Engr—Oct. 28, 1910. No. 18487 A.

Aeroplane Propellers.

Aeroplane Propellers. Trans. from *Le Mois Sci. et Ind.* Brief account of experiments by Capt. Dorand on the actual propelling power of propellers. 500 w. Prac Engr—Nov. 11, 1910. No. 18678 A.

Aeroplanes.

A Comparison of the Wright and Curtiss Aeroplanes. Considers the main points of difference. 1200 w. Yale Sci M—Nov., 1910. No. 18628 C.

Aeroplane Stability.

Researches on the Stability of Aeroplanes (Recherches sur la Stabilité des Aéroplanes). Victor Quittner. The first part of the serial discusses longitudinal stability. Mathematical. Ills. Serial. 1st part. 3600 w. Tech Mod—Oct., 1910. No. 18712 D.

We supply copies of these articles. See page 670.

Air Resistance.

The Aerial Fleet (La Flotte Aérienne). L. Marchis. A thorough discussion of air resistance and its measurement, and a description and discussion of early and modern airships and aeroplanes. Ills. 27600 w. Tech Mod—Oct., 1910. (Supplement). No. 18715 N.

Airships.

The Gas-Supported Airship. Carl Dienstbach. A discussion of the dirigible balloon and its many designs, describing types and the fascination of air travel. 2800 w. Sci Am—Nov. 12, 1910. No. 18457.

Lessons from the Wellman Expedition. Henry Harrison Suplee. Suggestions for the development of the dirigible balloon. 1200 w. Cassiers Mag—Nov., 1910. No. 18618 B.

Recent European Progress in Dirigible Balloons. W. A. Blonck. Illustrated review of the types and construction. 1200 w. Jour W Soc of Engrs—Oct., 1910. No. 18835 D.

Airship Sheds.

German Airship Sheds. Illustrates and describes the sheds erected at Dusseldorf and at Gotha. 350 w. Sci Am Sup—Nov. 12, 1910. No. 18461.

Altitude.

Measuring the Altitude Reached by Aeroplanes; Harvard-Boston Aero Meet. J. Albert Holmes. Gives map of the aviation field and explains method of measuring altitude used, giving tabulated results. 2000 w. Eng News—Nov. 10, 1910. No. 18449.

Balloon Construction.

An Experimental Investigation of the Strength of the Cordage used in Balloon Construction (Recherches expérimentales sur la Résistance des Cordages usités en Aérostation). Capitaine Do. Discusses the materials used in the manufacture of cordage for this purpose and records the results of tests. Ills. Serial. 1st part. 2400 w. Tech Mod—Sept., 1910. No. 18710 D.

Competitions.

The International Aviation Meet. An illustrated account of performances at Belmont Park. 3500 w. Sci Am—Nov. 5, 1910. Serial. 1st part. No. 18382.

See also Altitude, under AERONAUTICS.

Exhibitions.

Aeroplanes in Paris. Discusses the aeroplanes exhibited at the Paris Show. Ills. 1800 w. Engr, Lond—Oct. 28, 1910. Serial. 1st part. No. 18502 A.

The Second Aerial Navigation Exhibition (La IIe Exposition de Locomotion aérienne). G. Espitallier. Describes the exhibits at the Paris show, Oct. 15-Nov. 2, 1910. Ills. 6300 w. Génie Civil—Oct. 29, 1910. No. 18727 D.

Military.

See Guns, under MISCELLANY.

AUTOMOBILES.

Agricultural.

Mechanical Cultivation (La Culture mécanique du Sol). G. Coupan. Detailed description of the König motor harrow, and the Bajac tractor. Ills. 3000 w. Génie Civil—Oct. 29, 1910. No. 18728 D.

Brakes.

Brakes and Breaking. Discusses brake maintenance. 2000 w. Auto Jour—Oct. 29, 1910. No. 18473 A.

Commercial Vehicles.

Motor Trucks and Delivery Wagons. H. W. Perry. Illustrates and describes some types used and special features of their construction. 2000 w. Ir Age—Nov. 24, 1910. No. 18855.

Hauling Lumber by Motor Truck in Boston. C. F. Marden. Illustrates and describes electric and gas motor trucks especially fitted for the delivery of lumber. 3500 w. Com Veh—Nov., 1910. No 18306 C.

The Commercial Vehicle Competition Organized by the Minister of War and the Automobile Club, 1910 (Le Concours de Véhicules industriels organisé par le Ministère de la Guerre et l'Automobile-Club, en 1910). E. Girardault. Summarizes the characteristics of the contestants and the results of the trials. Ills. 3500 w. Génie Civil—Oct. 1, 1910. No. 18719 D.

Construction.

Hickory. Extracts from a Bul. of the U. S. Forest Service. Deals with its use in automobile work. 3000 w. Automobile—Nov 24, 1910. No. 18881.

Some Examples of the Use of Drop Forgings in Automobile Construction. John Coapman. Explains advantages of this method of construction, showing some of the parts used. 1400 w. Horseless Age—Nov. 2, 1910. No. 18368.

Small Cars (Kleine Wagen). A. H. Simon. Describes various types of cars of small power. Ills. Serial. 1st part. 1800 w. Motorwagen—Sept. 20, 1910. No. 18780 D.

Cunningham.

Cunningham Automobile. Illustrated description of a new car made by this Rochester, N. Y., company. 1500 w. Automobile—Nov. 3, 1910. No. 18358.

Deasy.

The Latest Deasy Cars. Illustrates and describes a new model of 12 h. p. and a new type of 4-speed gear box. 1200 w. Autocar—Nov. 5, 1910. No. 18556 A.

Electric Batteries.

Practical Care of Electric Vehicle Batteries. S. C. Harris. From a paper read before the Elec. Veh. Assn. of Am. Discusses the components of the electric storage battery and the methods for putting a battery into service and maintaining its efficient operation. 2000 w. Com Veh—Nov., 1910. No. 18307 C.

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Engineering.

The Advance and Development of Automobile Engineering. F. W. Lanchester. Pres. address before the Inc. Inst. of Auto. Engrs. A general review. 3500 w. Auto Jour—Oct. 22, 1910 Serial 1st part. No. 18279 A.

Exhibitions.

Motor Car Exhibitions at Olympia. Reviews the new features shown, with illustrations. 1500 w. Engr, Lond—Nov. 4, 1910. Serial. 1st part. No. 18581 A.

Auto Technology. Illustrated descriptions of improvements in design observed at the Olympia Exhibition. 3000 w. Auto Jour—Nov. 5, 1910. No. 18559 A.

Carriage Work at Olympia. An illustrated outline of improvements in design with consideration of the latest tendencies and the reasons which have brought them about. 2500 w. Autocar—Nov. 5, 1910. Serial. 1st part. No. 18558 A.

Automobiles at the Brussels Exposition (Motorwagen und Fahrzeugmaschinen für flüssigen Brennstoff auf de Weltausstellung in Brüssel 1910). A Heller. A brief review of the exhibits. Ills. Serial. 1st part. 3200 w. Zeitschr d Ver Deutscher Ing—Oct. 8, 1910. No. 18920 D.

Fuels.

The Heavier Liquid Fuels. Robert W. A. Brewer. A report of experiments and results with various fuels. 2500 w. Autocar—Nov. 19, 1910. No. 18970 A.

Garages.

A Large Electric Vehicle Garage at Toledo, Ohio. Illustrated description of a large garage, equipped for up-to-date service. 1200 w. Elec Wld—Nov. 3, 1910. No. 18342.

Heating.

Keeping the Car Warm in Winter. Illustrates and describes types of heaters used. 1200 w. Horseless Age—Nov. 23, 1910. No. 18886.

Ignition.

A Self-Timing Magneto. Illustrated description of the latest Eisemann model. 1700 w. Auto Jour—Oct. 29, 1910. No. 18475 A.

Bosch Auxiliary Ignition. Illustrated description of an improvement which secures easy starting for single and twin-cylinder engines. 1000 w. Auto Jour—Nov. 5, 1910. No. 18560 A.

Lighting.

The "Carbic" Acetylene System. Illustrated review of the present position of this invention for headlight management. 2500 w. Oct. 29, 1910. No. 18476 A.

Motor Balancing.

Torque and Balancing of Internal-Combustion Engines. A. J. T. Kersey. Compares torque diagrams with different arrangements of cylinders and cranks in the present article. 1500 w. Mech Engr—Nov. 11, 1910. Serial. 1st part. No. 18680 A.

Motors.

The Olympia Motor Exhibition. A general review with description of interesting exhibits. 4000 w. Engng—Nov. 11, 1910. Serial. 1st part. No. 18681 A.

Motor Speed.

Fast *versus* Slow Speed Motors for Cars. Dscusses the merits of the two classes of engines. 2700 w. Engng—Oct. 21, 1910. No. 18294 A.

Motor Valves.

The Slide Valve. Reply to Criticisms. Charles Y. Knight. Reply to a "manufacturer of poppet valve engines," who criticized the slide valve. 8500 w. Autocar—Oct. 22, 1910. No. 18280 A.

Poppet Valves and Slide Valves. A rejoinder to Mr. Knight's remarks on "Some Criticisms of the Slide Valve Engine," by Claude Johnson. 8500 w. Autocar—Nov. 5, 1910. No. 18557 A.

Poppet Valves and Slide Valves. Editorial summary of their respective advantages and drawbacks. 2500 w. Autocar—Oct. 29, 1910. No. 18477 A.

Valve Timing of Automobile Engines. C. T. Schaefer. A discussion of the valve setting of French and American gasolene motors. 1500 w. Am Mach—Vol. 33. No. 46. No. 18601.

Omnibuses.

A Rural Motor-Omnibus Undertaking (Aus der Praxis einer ländlichen Automobilomnibus-Betriebsgesellschaft). Th. Wolff-Friedenau. Describes technical and economic features of a rural motor-omnibus line in Germany. 4200 w. Zeitschr d Mitt Motorwagen Ver—Oct. 31, 1910. No. 18778 D.

Pressure Indicators.

A Good "Tuning-Up" Instrument. Illustrated description of the Okill pressure indicator, explaining its usefulness. 1500 w. Auto Jour—Nov. 19, 1910. No. 18971 A.

Sheffield-Simplex.

The New 25 h. p. Sheffield-Simplex. Illustrates and describes the three-speed gear box on the back axle, the form of distribution gear and magneto drive, and other points of design. 1200 w. Autocar—Oct. 29, 1910. No. 18478 A.

Silencers.

Some of the Latest European Creations. Chester S. Ricker. Illustrates and describes new features introduced for silencing cars, and other improvements. 2000 w. Horseless Age—Nov. 23, 1910. No. 18885.

Sledges.

Automobile Ice-Sled. Frederick K. Lord. Plans and description of a motor-driven sled that can be built cheaply. 1800 w. Sci Am—Nov. 19, 1910. No. 18645.

Speed.

Speed with Security. Marius C. Krarup. Discusses needless causes of traffic disturbance. 1000 w. Automobile—Nov. 10, 1910. Serial. 1st part. No. 18467.

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Starters.

A Very Compact Self-Starter. Illustrated detailed description of the latest Simms magneto device. 1500 w. Auto Jour—Oct. 22, 1910. No. 18278 A.

Tires.

Imprènt Method of Testing. Illustrates and describes methods of testing tires to determine the area of contact and desired inflation. 700 w. Automobile—Nov. 10, 1910. Serial. 1st part. No. 18466.

Transmisions.

Some Ideas on the Design of Friction Driven Cars. Victor Jakob. Some features of the design which might be improved, and suggests methods for successful design. Ills. 5500 w. Horseless Age—Nov. 9, 1910. No. 18546.

Worm Driving. Noble and Prewitt. Remarks on the progress evident in the worm drive, its advantages, efficiency, etc., discussing types. Ills. 3500 w. Horseless Age—Nov. 16, 1910. No. 18669.

The Efficiency of the Nacke Chain Transmission (Der Wirkungsgrad der Uebertragungsgetriebe zwischen Motor und Triebrädern eines Kraftfahrzeuges mit Kettenantrieb der Firma E. Nacke, Coswig). H. Scheit and Bobeth. A report of tests by the Royal Saxon Testing Institution. Ills. 2200 w. Zeitschr d Mitt Motorwagen Ver—Oct. 15, 1910. No. 18777 D.

Wheels.

The Segment-Detachable Motor Car Rim. Illustrated description of a device aiming to eliminate troubles in removing tires. 1000 w. Engr, Lond—Oct. 28, 1910. No. 18505 A.

Wolseley.

Wolseley. Illustrated description of the new cars for 1911. 600 w. Auto Jour—Oct. 22, 1910. No. 18277 A.

Wolseley Cars at the Motor Show at Olympia. Illustrated description of cars exhibited and improvements in details. 2500 w. Engng—Nov. 4, 1910. No. 18574 A.

COMBUSTION MOTORS.

Flywheels.

See same title, under MACHINE ELEMENTS AND DESIGN.

Fuels.

See same title, under AUTOMOBILES.

Gas Engines.

The Gas Engine as a Power Factor in Practical Operation. D. R. Ryder. An illustrated article presenting information and letters from users of gas engines of various sizes. 1500 w. Pro Age—Nov. 15, 1910. No. 18518.

Gas-Engine Troubles.

Large Gas Engines and Their Troubles. Frank Foster. Discusses the difficulties which must be overcome by the makers. Ills. 5000 w. Mech Engr—Nov. 4, 1910. No. 18568 A.

Large Gas Engines and Their Troubles. F. Foster. Abstract of a paper read at the Manchester, Eng., Engng. Ex. Discusses the difficulties experienced in their manufacture, describing the improved forms of construction now adopted. 3000 w. Elect'n, Lond—Oct. 28, 1910. No. 18485 A.

Gas Power Plants.

The Design of Small Pressure Gas Plants. A. H. Downes-Shaw. Notes on the requirements and information relating to the design of small plants. Ills. 2200 w. Mech Wld—Oct. 28, 1910. No. 18493 A.

First Large Gas-Engine Installation in American Steel Works. E. P. Coleman. Description and operating characteristics of sixteen blowing-engine units of 2000 H. P. each, eight electric-generating units of 1000-H. P. each, and gas-cleaning plants of the Lackawanna Steel Co. Ills. 13500 w. Jour Am Soc of Mech Engrs—Nov., 1910. No. 18271 F.

Oil Engines.

A Combustion Motor Using Heavy Oil Applied to a Railway Motor Car (Motore a Petrolio pesante applicato ad una Automotrice ferroviaria). E. Mariotti. Detailed description of the motor and car. Ills. Serial. 1st part. 2600 w. Ing Ferro—Oct. 16, 1910. No. 18740 D.

See also same title, under MARINE AND NAVAL ENGINEERING.

Producer Gas.

The Dangers of Producer Gas. From a memorandum as to the use of water gas, suction gas, and other gases in factories, issued by the Factory Dept. of the Home Office. 1800 w. Mech Engr—Oct. 28, 1910. No. 18492 A.

HEATING AND COOLING.

Air Humidifying.

Air Conditioning in Textile Mills (Condizionatura dell' Aria nei Cotonifici). G. Beltrami. A discussion of humidifying apparatus and practice. Serial. 1st part. 1700 w. Industria—Oct. 2, 1910. No. 18736 D.

Cooling Towers.

A Combined Cooling Tower Foundation and Accumulator House. Warren H. Miller. Illustrated description of the unique construction at the Lundy power house of the Paris Gas Co. 1000 w. Eng Rec—Nov. 26, 1910. No. 18955.

Hot-Air Heating.

Twin Furnaces for Residence Heating. Plans and description of a separate pipe system. 1500 w. Met Work—Nov. 5, 1910. No. 18367.

Hot-Water Heating.

A Model Heating System of Glass Tubing. A. Sayers. Illustrates and describes the iodide method of demonstrating the flow of water through pipes. 1500 w. Heat & Vent Mag—Nov., 1910. No. 18814.

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Plumbing.

Water Supply for a Public Bath. Illustrates and describes the piping details of the hot and cold water service of a Brooklyn public bath. 2500 w. Met Work—Nov. 19, 1910. No. 18640.

Radiators.

The Relative Efficiency and Resistance to Corrosion of Different Types of Radiators. Herbert Orr. Read before the Nat. Dist. Heat. Assn. Discusses the arguments advanced against sheet-metal radiation, showing their fallacy, and considers other types. 2000 w. Dom Engng—Nov. 19, 1910. No. 18693.

Refrigeration.

Notes on Refrigeration. J. H. Mason. Reviews the history of refrigeration, describing modern methods and apparatus. Plates. Short discussion. 4500 w. Jour S Africa Assn of Engrs—Sept., 1910. No. 18473 F.

Heat and Production of Cold. J. F. H. Koopman. From introduction to a course of lectures on the refrigerating industry at the Technical University of Delft, Holland. 4500 w. Ice & Refrig—Nov., 1910. No. 18384 C.

The Working Fluid in Refrigeration. H. J. Macintire. Observations on the choice of ammonia, carbon dioxide, sulphur dioxide, or other refrigerant as the working fluid in compression refrigerating machines. 1200 w. Ice & Refrig—Nov., 1910. No. 18385 C.

Installing Refrigerating System. F. E. Matthews. Explains how joints are made and leaks detected and repaired. 1200 w. Power—Nov. 22, 1910. No. 18690.

Electric Refrigeration in the Meat Industry. R. L. Lloyd. An illustrated article giving information concerning plants of this character. 1800 w. Elec Rev & W Elec—Nov. 5, 1910. No. 18389.

Charging a Refrigerating System. F. E. Matthews. Gives directions for charging and tables for estimating the amount of charge. 2000 w. Power—Nov. 29, 1910. No. 18969.

The Second International Congress of the Cold (II^e Congres international du Froid). E. Lemaire. A brief review of the proceedings and of the papers read at the refrigeration congress at Vienna, Oct. 6-12, 1910. 2000 w. Génie Civil—Oct. 29, 1910. No. 18729 D.

Ventilation.

Ventilation in Schools. W. A. Evans. Read before the Am. Med. Assn. Explains the scheme of ventilation advised by the writer. 3000 w. Met Work—Nov. 26, 1910. No. 18883.

Problems in Ventilation. A. K. Campbell. Criticism of views of Dr. W. A. Evans on school ventilation and explains author's views on improving indoor atmosphere. 2500 w. Met Work—Nov. 26, 1910. No. 18882.

HYDRAULIC MACHINERY.

Centrifugal Pumps.

The Physical Phenomena Existing in Centrifugal Pumps (Considérations sur les Phénomènes physiques existant dans les Pompes centrifuges). L. Bergeron. Discusses from a physical and practical point of view the various theories of centrifugal-pump action, with special reference to diffusers. Ills. 5000 w. Rev de Mécan—Oct., 1910. No. 18709 E + F.

Electric Pumping.

Discussion on Hydroelectric Power as Applied to Irrigation," San Francisco, Cal., May 6, 1910. Discussion on John Coffee Hays' paper. 5000 w. Pro Am Inst of Elec Engrs—Nov., 1910. No. 18841 F.

See also Pumping Plants, under HYDRAULIC MACHINERY.

Gas Pump.

Humphrey Pumps and Compressors. Herbert A. Humphrey. Read before the Manchester Assn. of Engrs. Illustrates and describes designs and recent improvements. 2500 w. Mech Engr—Nov. 18, 1910. Serial. 1st part. No. 18986 A.

Pumping Plants.

Lawrence Avenue Pumping Station. Illustrated detailed description of this station and its equipment for pumping combined sewage of Chicago and mixing it with lake water. 1500 w. Munic Jour & Engr—Nov. 23, 1910. No. 18858.

Electric Pumping Plant for Irrigation in Utah. Describes the plant and the favorable conditions for its development. Ills. 2000 w. Eng Rec—Nov. 12, 1910. No. 18510.

The New Pumping Plants at Lyons (La Transformation des Usines élévatoires de la Ville de Lyon). Describes large installations of centrifugal pumps driven by electric motors. Ills. 2800 w. Génie Civil—Oct. 22, 1910. No. 18725 D.

Pumps.

The Weir Feed Pumps. Illustrated description. 800 w. Col Guard—Oct. 28, 1910. No. 18494 A.

Turbine Plants.

The Turbine Plant at Great Falls, Newfoundland (Die Turbinen der Wasserkraftanlage in Grand Falls, Neufundland). V. Gelpke. Describes the machinery installed by Amme, Giesecke & Konegen, Braunschweig, Germany. Ills. 3300 w. Zeitschr d Ver Deutscher Ing—Oct. 29, 1910. No. 18928 D.

MACHINE ELEMENTS AND DESIGN.

Ball Bearings.

Ball Bearings in Machine Tool Construction. Henry Hess. From a paper read before the Nat. Machine Tool Bldrs. Assn. Illustrates and describes present standard practice of American and German builders. 1800 w. Ir Age—Nov. 3, 1910. No. 18324.

We supply copies of these articles. See page 670.

Cams.

Notes on Cam Forms (Betrachtungen über Nockenformen). F. Dinslage and K. Praetorius. A discussion of the laying out of cams for automobile motors. Ills. Serial. 1st part. 1000 w. Motorwagen—Sept. 10, 1910. No. 18779 D.

Crane Hooks.

The Design of Hoisting Hooks. Axel K. Pedersen. Chart, with formulae, showing the relations of the general dimensions. 1000 w. Am Mach—Vol. 33. No. 47. No. 18863.

Curved Rods.

A Simple Method of Determining the Deformation of Rods of Uniform Curvature (Einfaches Verfahren zur Ermittlung der Formänderung eben gekrümmter stabförmiger Körper). R. Baumann. Mathematical explanation of method. Ills. 5500 w. Zeitschr d Ver Deutscher Ing—Oct. 1, 1910. No. 18917 D.

Drawings.

Detail Drawings in Mass Production. Alban Rice. Considers examples of right and wrong dimensioning, detail design, etc. Ills. 2500 w. Am Mach—Vol. 33. No. 46. No. 18603.

Flywheels.

Flywheels for Internal Combustion Engines. D. O. Barrett. Refers only to internal-combustion engines of the single-cylinder, single-acting, four-cycle type with two flywheels. Formulae and deductions are given. 1500 w. Mach, N Y—Nov., 1910. No. 18375 C.

Photography.

The Application of Photography to Industrial Design and to Surveying (Application de la Photographie au Dessin industriel et au Lever des Plans). F. Sautier. Shows how plans of machines and other objects may be developed from photographs, and the application of photographic surveying from balloons. Ills. 2600 w. Tech Mod—Oct., 1910. No. 18714 D.

Rivetted Joints.

Failures of Rivetted Joints in Steam Boilers (Het Scheuren van Klinknaden bij Stoomketels). L. Bienfait. Gives results of experiments by the author, comparing them with the results of previous investigations. Ills. 2600 w. De Ingenieur—Oct. 1, 1910. No. 18932 D.

Shafts.

The Effect of Keyways on the Strength of Shafts. Herbert F. Moore. An account of a brief investigation in the Laboratory of Applied Mechanics, Univ. of Ills., describing the tests and giving data and results. Ills. 3500 w. Univ of Ills, Bul. 42—Dec. 19, 1909. No. 18811 N.

Structural Steel.

Notes on Structural Steel Detailing for Mechanical Draftsmen. Harry Gwinner. Ills. 1500 w. Mach, N Y—Nov., 1910. No. 18380.

MACHINE WORKS AND FOUNDRIES.

Automatic Machines.

Automatic Commutator-Segment Machine. Illustrated detailed description of an automatic machine, shown at the Brussels Exhibition, for slotting commutator bars and soldering them with their strips. 1500 w. Engng—Nov. 11, 1910. No. 18682 A.

Blacksmith Shops.

A Smith Shop with Water Gas Fuel. Illustrates and describes the layout and equipment of new shops at Scranton, Penn., for the D., L. & W. Ry. 2000 w. Am Mach—Vol. 33. No. 46. No. 18600.

Bronze Founding.

Japanese Bronze Founding (Japanischer Bronzeguss). H. Heiland. A brief review of native practice in bronze working. Ills. Serial. 1st part. 1200 w. Giesserei-Zeit—Oct. 1, 1910. No. 18754 D.

Case Hardening.

The Case Hardening and Heat Treatment of Low Carbon Steels. A. C. Sladky and A. F. Schultz. A report of research work. 2000 w. Wis Engr—Nov., 1910. Serial. 1st part. No. 18824 C.

The Gas Process of Case Hardening (Sur la Cémentation par les Gaz). A. Portevin. A general discussion, and a review of the publications of Prof. Giolitti and his assistants. Ills. 9500 w. Rev de Métal—Oct., 1910. No. 18703 E + F.

Chip Briquetting.

The Influence of Chip Briquettes on the Quality of Cast Iron (Wie erklärt sich der Einfluss der Spänebriketts auf das Gusseisen). Engelbert Leber. Offers an explanation of their effect in improving the quality of cast iron. 3800 w. Stahl u Eisen—Oct. 12, 1910. No. 18748 D.

Cutting Tools.

Cutting Speed and Grinding of High-Speed Steels. Wolfgang Koch. Gives opinion of several German firms based on experience, as expressed in reply to an inquiry recently sent. 2200 w. Mach, N Y—Nov., 1910. No. 18374 C.

Heat Treating High Speed Tools. C. P. Berg. Report of experimental work for determining the degree of temper that gives different steels the maximum cutting efficiency. Ills. 2200 w. Am Mach—Vol. 33. No. 45. Serial. 1st part. No. 18471.

Forging.

Cold Forging. J. F. Springer. Illustrated description of a swaging machine and its operation. 1500 w. Sci Am—Nov. 5, 1910. No. 18381.

Foundries.

A Crucible Steel Casting Plant and Its Methods. Illustrates and describes the furnaces and the methods employed. 1600 w. Castings—Nov., 1910. No. 18649.

Foundry Drying Rooms.

Foundry Drying Rooms (Die Trockenkammer in der Giesserei). E. Freytag. A

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discussion of the design and equipment of drying rooms for moulds and cores. Ills. Serial. 1st part. 2700 w. Giesserei-Zeit—Oct. 15, 1910. No. 18756 D.

Foundry Practice.

Producing Malleable Stove Plate. H. Cole Estep. Illustrated description of the equipment and practice of a large stove plate foundry, in which organization and methods effect great economies. 2500 w. Foundry—Nov., 1910. No. 18314.

See also Patterns, under MACHINE WORKS AND FOUNDRIES.

Galvanizing.

Sherardizing Small Metal Goods in a Connecticut Plant. Illustrates a New Haven, Conn., plant, describing the methods used. 1200 w. Brass Wld—Nov., 1910. No. 18624.

Gear Cutting.

Do Gear Hobbing Machines Cut Flats. F. O. Farwell. A defense of the gear-hobbing machine. Ills. 2200 w. Am Mach—Vol. 33. No. 45. No. 18470.

Cutting Gears on the Slotter. A. Wood. Illustrated explanation of a method of machining large gears. 800 w. Am Mach—Vol. 33. No. 44. No. 18416.

The Cutting of Involute Gears of any Desired Angle of Contact on Planing Machines (Ausführung von Evolventenverzahnungen mit beliebigem Eingriffwinkel auf Maschinen, die nach dem Wälzverfahren arbeiten). Rudolf Plessing. Describes methods of producing gears with angles of contact above 15 degrees. Ills. 2400 w. Zeitschr d Ver Deutscher Ing—Oct. 1, 1910. No. 18918 D.

Grinding Machines.

An Investigation of Grinding Economy (Versuche zur Ermittlung der günstigsten Arbeitsweise der Rundschleifmaschine). W. Pockrandt. Reports tests made to determine the most economical conditions of operation of grinding machines. Ills. Serial. 1st part. 3750 w. Zeitschr d Ver Deutscher Ing—Oct. 15, 1910. No. 18923 D.

Lathes.

Two Historical Lathes. Illustrates and describes the Roberts' screw-cutting lathe of 1820, and the Roberts' sliding lathe of 1817. 1800 w. Engr, Lond—Oct. 21, 1910. No. 18299 A.

The Gridley Automatic Lathe. Illustrated description of a motor-driven single-spindle machine. 600 w. Engr, Lond—Nov. 4, 1910. No. 18587 A.

Automatic Lathe Work. P. V. Vernon. Read before the Rugby Engng Soc. Discusses the effect of automatic work on the time and cost of production, and details of automatic turning machines. 4000 w. Engr, Lond—Nov. 18, 1910. No. 19001 A.

Load Tests of a High-Speed Lathe (Leistungsversuche an einer Schnelldrehbank). Hans Ihle. A report of tests to determine the relation between the load, metal removed, and cutting speed. Ills. 2500 w. Zeitschr f Werkzeug—Oct. 5 1910. No. 18785 D.

Machine Tools.

Machine Tools at the Brussels Exposition. J. O. Newman. Illustrates and describes some American, German, and British exhibits. 4000 w. Cassier's Mag—Nov., 1910. No. 18613 B.

Machine Tools from the User's Standpoint. Read before the Nat. Machine Tool B'lders. Assn. John Riddell's discussion of machine tool design, with instructive criticisms. 3500 w. Ir Age—Nov. 10, 1910. No. 18430.

Can the Efficiency of Shop Tools Be Increased. Gives seven of the twenty articles submitted in a competition. 9500 w. Ry Age Gaz—Nov. 4, 1910. No. 18370.

Molding.

The Making and Molding of a Screw Propeller. Illustrates and describes English foundry practice in molding by a single blade. 1800 w. Castings—Nov., 1910. No. 18650.

The Molding of Ships' Propellers (Die Schifsschrauben und ihre Formmethoden). H. Vetter. Considers their design, methods of making patterns, and molding practice. Ills. Serial. 1st part. 1800 w. Giesserei-Zeit—Oct. 15, 1910. No. 18757 D.

Molding Machines.

The Present Status of Machine Molding and Molding Machines (Gegenwärtiger Stand der Formmaschinenarbeit und des Formmaschinenbaues). Carl Irresberger. A profusely illustrated review, referring principally to German practice. 8000 w. Stahl u Eisen—Oct. 12, 1910. No. 18747 D.

Patterns.

Patternmakers and the Different Ways of Making Castings. Jabez Nall. Shows, by comparison of work, the correct and incorrect methods. Ills. 2500 w. Castings—Nov., 1910. No. 18648.

Pipe Founding.

The Manufacture of Cast-Iron Pipe and Pipe Fittings in Permanent Moulds (Fabrication des Tuyaux et Pièces de Raccords en Fonte avec des Moules permanents). Translations of papers by Simmersbach and Irresberger in *Stahl und Eisen*. Ills. 4000 w. Rev de Métal—Oct., 1910. No. 18704 E + F.

Punch Presses.

Standardizing the Press Room. C. A. Thompson. Explains a scheme for arranging punch presses of various sizes to provide uniform working clearance between ram and bed. Ills. 800 w. Am Mach—Vol. 33. No. 47. No. 18866.

Shop Appliances.

Suggestions in Tool Designing. E. E. Minard. Considers points in connection with jig and fixture designing. 1800 w. Am Mach—Vol. 33. No. 47. No. 18868.

Tools and Dies Used in the Manufacture of Jewelry. Chester L. Lucas. Illus-

trated description of tools and methods used in factories at Providence, R. I. 3000 w. Mach, N Y—Nov., 1910. No. 18376 C.

Shop Heating.

The Heating of Factory Buildings. Oscar E. Perrigo. Explains the advantages of the positive heated air system, describing a typical installation. Ills. 3000 w. Ir Trd Rev—Nov. 10, 1910. No. 18535.

Shop Lighting.

The Lighting of Industrial Plants (L'Illuminazione degli Ambienti industriali). Francesco Massarelli. A discussion of the hygiene of the eye, modern light sources, and methods of illumination. 3000 w. Industria—Oct. 9, 1910. No. 18734 D.

Shop Practice.

Fixing Work on the Tables of Machine Tools. George W. Burley. Illustrates and describes methods used with the more important machine tools. 1500 w. Mech Wld—Nov. 18, 1910. Serial. 1st part. No. 18987 A.

Methods Used in Building Lathes. F. A. Stanley. Illustrates and describes the processes and tools employed, and the methods used by a Cincinnati company. 2200 w. Am Mach—Vol. 33. No. 44. No. 18418.

Making Locking Bolt Blocks and Spindle Carrier for Gridley Turret Lathe. F. R. Humphrey. Illustrated detailed description. 1000 w. Mach, N Y—Nov., 1910. No. 18379 C.

Machining Power Punch Presses. F. A. Stanley. Illustrates and describes features of the practice of a Cincinnati shop. 1500 w. Am Mach—Vol. 33. No. 46. No. 18602.

Adjustable Die Work on the Ellis Adding Typewriter. Ralph E. Flanders. Fourth and last of a series on the construction, action and manufacture of an adding typewriter. 2500 w. Mach, N Y—Nov., 1910. No. 18378 C.

Threading Sheet Metal Screws. H. W. Sirius. Considers proportions of thread parts, and some points in setting up for threading. Ills. Am Mach—Vol. 33. No. 45. No. 18469.

Broaches and Broaching Processes. C. B. Auel. Illustrates and describes details of the work, broaching tools, finishing allowances and other items. 3000 w. Am Mach—Vol. 33. No. 45. No. 18468.

Shop Kinks. F. E. Lister. Illustrates and describes devices and methods used in the Morris Park shops of the Long Island railroad. 6500 w. Ry Age Gaz—Nov. 4, 1910. No. 18371.

See also Engine Erection, under STEAM ENGINEERING.

Shops.

Organization of a German Pump Plant. F. zur Nedden. Illustrates and describes a specialized German machine shop, organized on stated principles. 1200 w. Am Mach—Vol. 33. No. 46. No. 18604.

Shop Ventilation.

The Economics of Factory Ventilation. Royce W. Gilbert. Discusses the effect of ventilation on the efficiency of the workers. 3000 w. Engineering Magazine—Dec., 1910. No. 18940 B.

The Extraction and Collection of Dust in Manufacturing Operations. Illustrates and describes types of dust collectors and their use. 2000 w. Engr, Lond—Oct. 28, 1910. No. 18504 A.

Tempering.

Hardening Steel with Electricity. E. F. Lake. Considers the different methods by which electricity is used for heating steel to harden and temper it, illustrating and describing apparatus. 3000 w. Am Mach—Vol. 33. No. 47. No. 18867.

Welding.

Oxy-Acetylene in Metal Working. A. Cressy Morrison. Discusses the apparatus used, dangers, utility, etc. 2000 w. Am Mach—Vol. 33. No. 47. No. 18865.

Oxy-Acetylene Welding. J. F. Springer. Illustrated discussion of this process as applied to boiler work. 3000 w. Boiler Maker—Nov., 1910. No. 18438.

The Acetylene Welding Torch. J. F. Springer. Discusses the mixing of gases in the tip of a welding torch, how the high temperature is maintained, how the danger of explosion has been eliminated, and the method of using the torch. 2500 w. Am Engr & R R Jour—Nov., 1910. No. 18426 C.

The "Incanto" Oxy-Acetylene System of Autogenous Welding and Cutting. Apparatus view and description. 2500 w. Prac Engr—Oct. 21, 1910. No. 18288 A.

Wire Drawing.

An Improved Machine for Re-Making Wire Drawing Dies. Describes a machine for re-making dies after they have become worn by the passage of the wire. Ills. 2200 w. Prac Engr—Nov. 18, 1910. No. 18982 A.

MATERIALS OF CONSTRUCTION.

Alloys.

Some Common Defects Occurring in Alloys. Cecil H. Desch. From a paper read before the Inst. of Metals. Detailed discussion of certain defects and their causes. 1800 w. Mech Wld—Nov. 18, 1910. Serial. 1st part. No. 18988 A.

Shrinkage of Alloys During Solidification. Donald Ewen and T. Turner. Read before the Inst. of Metals. Reports an investigation of the shrinkage of antimony-lead, and aluminium-zinc alloys during and after solidification. Ills. 7000 w. Engng—Nov. 11, 1910. No. 18685 A.

On Magnetic Alloys Formed from Non-Magnetic Materials. Alexander R. Ross. Read before the Inst. of Metals. A detailed account of research work and results. 4500 w. Engng—Nov. 4, 1910. No. 18578 A.

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"Stellite," a New Alloy. Elwood Haynes. Illustrated description of the alloy, describing its physical and chemical properties, its varieties and uses. 2500 w. Sci Am Sup—Nov. 19, 1910. No. 18647.

Alloy Steels.

Recent Impact Tests at Various Temperatures (Nouveaux Essais au Choc a Températures variables). Léon Guillet and Louis Révillon. Reports results of tests on two nickel steels. Ills. 3000 w. Rev de Métal—Oct., 1910. No. 18700 E + F.

Copper.

Impurities in Tough Pitch Copper. F. Johnson. Abstract of a paper read before the Inst. of Metals. Gives results of investigations made to determine the effect of small quantities of bismuth, silver and aluminium upon the properties of copper when in the rough pitch state. 2000 w. Foundry—Nov., 1910. No. 18315.

Cast Copper of High Electric Conductivity. Dr. E. Weintraub. From a paper read before the Am. Elec.-Chem. Soc. Describes investigations made and the success obtained with "boronizing" copper. 1500 w. Ir & Coal Trds Rev—Nov. 18, 1910. No. 19002 A.

Fatigue.

The Fatigue of Metals and the New Methods of Testing (La Fatigue des Métaux et les nouvelles Méthodes d'Essais). Ch. Fremont. Considers fatigue as a cause of rupture, and discusses Karsten's proposed method for testing tubes. Ills. Serial. 1st part. 5000 w. Génie Civil—Oct. 22, 1910. No. 18726 D.

Metallography.

The Nature of the Slags Included in Basic Bessemer Steel (Sur la Nature des Scories interposées dans l'Acier Thomas). M. Matweieff. A metallographic study of methods by which slags of different characters may be recognized. Ills. 2500 w. Rev de Métal—Oct., 1910. No. 18702 E + F.

Microphotographic Apparatus (Appareil de Microphotographie). F. Robin. With a short note on the use of an oblique light in microphotography by MM. Portevin and Gartner. Discusses the microscope and other apparatus, the lighting of specimens, and the making of microchemical analyses. Ills. 5500 w. Rev de Métal—Oct., 1910. No. 18705 E + F.

Steel.

The Brittleness of Steel in Its Relation to Boilers. C. E. Stromeyer. Abstract from annual report to the Manchester Steam Users' Assn. Reports investigations made to determine the cause and to aid in the selection of proper material for boilers. 2000 w. Ir & Coal Trds Rev—Nov. 18, 1910. No. 19004 A.

Tool Steel.

High Speed Tool Steel. William Vanc. Brandt. Discusses methods of manufacture and heat treatment. 800 w. Ir Age —Nov. 3, 1910. No. 18322.

MEASUREMENT.

Gauges.

A System of Gages for Small Parts. Illustrates and describes a system used in several factories making light machines. 1500 w. Mach, N Y—Nov., 1910. No. 18377 C.

Laboratories.

The Work of the Reichsanstalt in 1909. A brief account of the work during 1909, based on the official report. 3000 w. Engng—Nov. 11, 1910. Serial. 1st part. No. 18684 A.

Melting Points.

The Joly Meldometer. Illustrated description of an instrument for accurately determining the melting points of minerals, metals, etc. 800 w. Mech Engr—Oct. 21, 1910. No. 18291 A.

Pitot Tube.

Determination of Current Direction by Means of the Pitot Tube (Bestimmung von Stromrichtungen mit Pitotrohren). Herr Schuster. Describes this application of the Pitot tube in the testing of water wheels, propellers, etc. Ills. 3300 w. Zeitschr d Ver Deutscher Ing—Oct. 8, 1910. No. 18922 D.

Pressure Gauges.

The Theory of Diaphragm Pressure Gauges (Theorie der Röhrenfedermanometer). H. Lorenz. Mathematical. 2300 w. Zeitschr d Ver Deutscher Ing—Oct. 29, 1910. No. 18930 D.

Testing Metals.

The Thermodynamics of Elastic and Permanent Deformation (Zur Thermodynamik elastischer und bleibender Formänderungen). Rudolph Plank. A mathematical attempt to explain thermodynamically the phenomena of heating in materials under test. Ills. 4950 w. Zeitschr d Ver Deutscher Ing—Oct. 29, 1910. No. 18929 D.

Water Meters.

The "Lea" Water Recorder. Illustrated description of an instrument for the measurement and automatic recording of the flow of water through channels and pipes. 3000 w. Prac Engr—Oct. 28, 1910. No. 18486 A.

POWER AND TRANSMISSION.

Air Compressors.

The Governing of Air Compressors. Remarks on experiments recently carried out on a modern two-stage compressor with inter-cooler, and arranged to unload by the closing of the main air inlet. 500 w. Engr, Lond—Oct. 21, 1910. No. 18303 A.

Two-Cylinder Single-Acting Air Compressor. Illustrated description of a modern, single-acting machine, built in England. 700 w. Engr, Lond—Nov. 4, 1910. No. 18586 A.

See also Turbo-Compressors, under POWER AND TRANSMISSION.

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Chain Driving.

High Power Chain Drives. Illustrates and describes noteworthy drives transmitting from 100 to 1000 h. p. 1500 w. Am Mach—Vol. 33. No. 47. No. 18862.

Costs.

Hourly Cost of Running Machinery D. C. Eggleston. Explains method of computing the hourly cost. 1200 w. Am Mach—Vol. 33. No 44 No. 18417.

Electric Driving.

Wiring on Motor-Driven Machinery. R. S. Watson. Discusses the best methods of machine wiring, describing the materials used and giving directions, rules, and tables. Ills. 4500 w. Mach, N Y—Nov., 1910. No. 18373 C.

Electric Drive as Affected by Incorrect Motor Sizes. Morse O. Dellplain. Discusses effects of over-motoring plants. 1200 w. Elec Wld—Nov. 24, 1910. No. 18893.

The Electrical Engineer and the Textile Machinist. F. Nasmith. Abstract of paper read at the Manchester Engng. Ex. Points out the large field for electrical devices in connection with the textile industry. 2000 w. Elect'n, Lond—Oct. 21, 1910. No. 18286 A.

Textile Type Motors, Albert Walton. An illustrated article explaining the requirements for this service and the necessity of designing motors to meet them. 2000 w. Elec Jour—Nov., 1910. No. 18804.

Some Notes on Electrical Plant and Supplies for India. G. E. Wright. Especially considers workshop electrification. Discusses the rating of dynamos and motors, and power house equipment. 1600 w. Elec Rev Lond—Oct. 28, 1910. No. 18480 A.

Discussion on "Interaction of Flywheels and Motors When Driving Roll Trains by Induction Motors." Jefferson, N. H., June 29, 1910. Discussion of F. G. Gasche's paper. 4000 w. Pro Am Inst of Elec Engrs—Nov., 1910. No. 18844 F.

Gas Compressors.

High Pressure Distribution Compressor, Emil Durr. Illustrates and describes two gas compressors recently installed at Millville, N. J. 500 w. Pro Age—Nov. 15, 1910. No. 18519.

Gas Power.

Power Gas and Its Development. J. S. S. Brame. Abstract of a lecture at the Sir John Cass Tech. Inst. The economy, possibilities, and utilization are discussed. 700 w. Elect'n, Lond—Oct. 21, 1910. No. 18285 A.

Lubricants.

Comparison of Lubricating Greases. Horace W. Gillett. Reports comparative tests of mineral and tallow greases, in which both Olsen and Thurston testing machines were used with varying bearing pressures. The tallow greases showed a lower melting point and a lower coefficient of friction. 1700 w. Power—Nov. 8, 1910. No. 18483.

Oils and Greases in Foundries and Metal-Working Plants (Allerei über Oele und Fette in ihrer Anwendung in Giessereien und Metallbearbeitungs-Fabriken). A discussion of lubricants in general, and of their application in metal working. Serial. 1st part. Giesserei-Zeit—Oct. 1, 1910. No. 18755 D.

Lubrication.

An Improved Method of Lubricating the Bearings of Gyrostats. Illustrates and describes improvements invented by Louis Brennan, which maintain a continuous circulation of the lubricant. 1800 w. Prac Engr—Nov. 4, 1910. No. 18567 A.

Mechanical Plants.

Mechanical Features of the Blackstone. Illustrates and describes the heating, ventilation and air cooling of this new hotel in Chicago. 3500 w. Met Work—Nov. 12, 1910. No. 18534.

The Power Plant and Heating System of the Soldan School. The Soldan High School, St. Louis, is a 3-story and basement structure, accommodating 1,600 pupils. Illustrated description of the mechanical equipment for heating, ventilating, lighting, and supplying power for manual training and other uses. 1200 w. Eng Rec—Nov. 12, 1910. No. 18514.

Power Plant of McCormick Building. Osborn Monnett. Illustrated description of the mechanical equipment of this 20-story building in Chicago. 1800 w. Power —Nov. 1, 1910. No. 18265.

Power Plants.

Some Troubles in Connection with Running Electrical Machinery. James A. Seager. Describes cases of trouble and the methods adopted to overcome the difficulties. 2000 w. Elec Rev & W Elect'n —Nov. 12, 1910. No. 18527.

Solar Motors.

Utilizing the Energy of Solar Radiation, the Wind, and Other Intermittent Natural Sources. R. A. Fessenden. Read before the British Assn. at Sheffield. Describes the method by which it is claimed the commercial utilization of such power has been accomplished. 3500 w. Mech Engr —Nov. 4, 1910. No. 18569 A.

A New Proposal to Secure Power on a Large Scale from Intermittent Natural Sources. Editorial discussion of the plan outlined by Prof. R. A. Fessenden for developing power from the sun and wind, comparing it with other schemes. 2000 w. Eng News—Nov. 17, 1910. No. 18608.

Turbo-Compressors.

Turbo-Blowers and Turbo-Compressors (Turbo-soufflantes et Turbo-compressors). A. Rateau. Describes the author's machines and illustrates a number of installations. 2400 w. All Indus—Oct., 1910. No. 18793 F.

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Tests of Rateau Turbo-Blowers (Versuche an Rateaugebläsen). H. Bonte. Reports tests for determining the efficiency of turbo-blowers both from electrical and thermal data. Ills. 5500 w. Zeitschr d Ver Deutscher Ing—Oct. 1, 1910. No. 18915 D.

Wind Power.

See Solar Motors, under POWER AND TRANSMISSION.

STEAM ENGINEERING.

Air Pumps.

Factors Affecting Air Pump Capacity. R. M. Neilson. Gives method of computing the capacity based upon the behavior of the mixture of air and vapor under the conditions existing in the condenser. 2000 w. Power—Nov. 29, 1910. No. 18967.

See also Condensers, under STEAM ENGINEERING.

Boiler Cleaning.

Boiler Tube Soot Cleaners. Warren O. Rogers. Illustrates and describes the principle types. 2500 w. Power—Nov. 8, 1910. No. 18434.

Boiler Evaporation.

Curves for Factors of Evaporation. Julian C. Smallwood. Gives chart for a wide range of boiler pressures and feed-water temperatures, with explanation. 500 w. Power—Nov. 22, 1910. No. 18691.

Boiler Failures.

Notes on Causes of Boiler Failure. A. A. Adler. Discusses overpressure, overheating, scale, and other causes. Ills. 1200 w. Power—Nov. 1, 1910. No. 18268.

Tests of Cracked Boiler Plates (Ergebnisse der Untersuchung von Kesselblechen, bei denen Rissbildungen aufgetreten sind). C. Back. Gives the results of physical, chemical, and metallographical tests on three fractured plates. Ills. 3300 w. Zeitschr d Ver Deutscher Ing—Oct. 22, 1910. No. 18925 D.

See also Rivetted Joints, under MACHINE ELEMENTS AND DESIGN.

Boiler Feed Pumps.

See Pumps, under HYDRAULIC MACHINERY.

Boiler Furnaces.

The Combustion of Gas Carbon. W. A. & R. L. Clarke. Read before the Pacific Gas Assn. Illustrates and describes a furnace designed to burn lamp-black, a by-product of the crude oil gas generator. 1500 w. Power—Nov. 15, 1910. No. 18530.

Experiments with Tile Roof Furnaces. A. Bement. Discusses the results of a series of tests made to determine the effect of roof tile on furnace conditions. Ills. 2500 w. Power—Nov. 15, 1910. No. 18531.

Boiler Repairs.

Installing Tubes in Boilers. H. S. Jeffrey. Explains how to remove defective tubes, illustrating and describing tools used in renewing and the method of handling them. 1200 w. Power—Nov. 1 1910. No. 18266.

Boilers.

Water-Tube Boilers. D. Wilson. Abstract of a paper before the Manchester Assn. of Engrs. Discusses the present position of the water-tube boiler, taking a modern electric generating plant as a standard, and considering the results obtained. 3800 w. Mech Engr—Oct. 28, 1910. No. 18491 A.

Boiler Waters.

Feed Water in Steam Boilers. Edward Ingham. Describes various forms of internal corrosion due to unsuitable water scale forming and its cause, and other troubles, and suggests methods of treating the water before using so as to avoid trouble. 2500 w. Ir & Coal Trds Rev—Nov. 11, 1910. No. 18687 A.

Condensers.

The Transmission of Heat in Surface Condensation. George A. Orrok. Describes experimental tests made to determine the heat transfer through various kinds of condenser tubes, and the laws governing its variation. Ills. 14000 w Jour Am Soc of Mech Engrs—Nov., 1910. No. 18270 F.

The Length of Condenser Tubes. R. M. Neilson. Discusses the effect of length, and the problem of determining the best length for any given conditions. 1300 w. Engr, Lond—Nov. 4, 1910. No. 18585 A.

The Effect of Air in Jet Condensers. Paul A. Bancel. Gives the method of figuring the capacities of air pumps. Ills. 2800 w. Power—Nov. 22, 1910. No. 18692.

Condensing Plant at the Brussels Exhibition. Illustrates and describes a new type of steam-condensing plant. 700 w. Engng—Oct. 28, 1910. No. 18497 A.

Plant for the Recovery of Exhaust Steam and for Power Generation of the Ernesto De-Angeli Company, Milan (Impianti con Ricupero del Vapore di Scappamento e nuova Centrale della Stamperia Italiana Ernesto De-Angeli). Carlo Bellini. Examines the economy of condensing and feed-water heating in turbine plants and describes the installation mentioned. Ills. 4500 w. Industria—Oct. 9, 1910. No. 18733 D.

Cooling Towers.

See same title, under HEATING AND COOLING.

Engine Design.

Compound Engine Proportions. Alwin Hofmann. Gives diagrams by means of which any one factor may be determined if the others are given. 2000 w. Power—Nov. 29, 1910. No. 18965.

Engine Economy.

The Influence of Throttling on Steam Consumption (Einfluss der Drosselung auf den Dampfverbrauch). Jar. Hybl. A mathematical investigation, with curves based on Mollier's new steam tables. Ills. 1500 w. Zeitschr d Oest Ing u Arch Ver —Oct. 21, 1910. No. 18787 D.

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Engine Erection.

The Fitting and Erecting of Engines. C. L. Browne. Considers the changes in the fitting shop brought about by modern conditions and self-hardening steel. 2500 w. Mech Wld—Nov. 4, 1910. Serial. 1st part. No. 18571 A.

Engine Governors.

Safety Stops for Steam Engines. W. H. Wakeman. Illustrates and describes especial designs of valves, some of which are operated by steam and others by electricity. 1700 w. Power—Nov. 1, 1910. No. 18267.

Engines.

The Development of the Steam Engine (Développement des Sciences mécaniques). V. Dwelshauvers-Dery. A historical review. Ills. 15000 w. All Indus—Oct., 1910. No. 18791 F.

An Engine Built Up of Sections. A. B Gould. Illustrated description of an engine for a locality only accessible by mule pack. 700 w. Power—Nov. 29, 1910. No. 18968.

The Stumpf Unidirectional Flow Steam Engine (La Machine à Vapeur a Equicourant). J. Stumpf. A description of the machine with a review of its performance and applications. Ills. 5000 w. All Indus—Oct., 1910. No. 18792 F.

Exhaust-Steam Regenerators.

Exhaust Steam Regenerators. Charles H. Smoot. Discusses the two general types, one in which the water passes through the incoming steam and the other in which the steam passes through the water. Ills. 5500 w. Power—Nov. 8, 1910. No. 18435.

Fuels.

The Volatile Matter of Coal. Horace C. Porter and F. K. Ovitz. A report on an investigation of the volatile matter in several typical coals—its composition and amount at different temperatures. Ills. 13000 w. Bureau of Mines—Bul. 1. No. 18817 N.

Fuel Testing.

Engineer's Problem in Selecting Coal. George H. Bayne. Gives directions for making standardization tests to determine the comparative evaporative efficiency of various coals. 2300 w. Power—Nov. 22, 1910. No. 18689.

Mechanical Stokers.

Under-Feed Automatic Stokers. J. F. Springer. Illustrated review of the development of this type. 2500 w. Power—Nov. 15, 1910. No. 18529.

Bennis Stokers at the Gemeente Electriciteitswerken, Amsterdam. Illustrated description of a very complete installation of sprinkling stokers and appliances. 600 w. Engng—Nov. 18, 1910. No. 18991 A.

The Triumph Stoker. An illustrated description of a stoker of the sprinkler type. 1200 w. Col Guard—Nov. 18, 1910. No. 18989 A.

Smoke Prevention.

The Problem of Smoke Abatement. D. T. Randall. Abstract of paper read before the Boston engineers. Considers localities using bituminous coal high in volatile matter. 4500 w. Power—Nov. 15, 1910. No. 18533.

The Economy of Smoke Prevention. J. A. Switzer. Considers the efficiency and operating cost of proper steam-jet devices for the boiler furnace. 1500 w. Engineering Magazine—Dec., 1910. No. 18945 B.

Steam Piping.

Design and Erection of Steam Piping. Francis H. Davies. Discusses the fundamental principles to be followed, and the materials which should be used. Ills. 4000 w. Power—Nov. 15, 1910. No. 18528.

Superheaters.

Superheaters. S. Lees. Discusses the layout of the superheater. 700 w. Elec Rev, Lond—Oct. 28, 1910. No. 18481 A.

Superheating.

A Case of Marine Superheating. Gives two engineer's logs showing the effect of superheating on the economy of marine engines. Table. 600 w. Engr, Lond—Nov. 18, 1910. No. 18998 A.

Turbine Design.

The Steam Turbine in Germany. F. E. Junge and E. Heinrich. Points out the tendency of the principal types of axial turbines to merge into one standard design. 3000 w. Power—Nov. 8, 1910. No. 18433.

Turbine Governing.

Oscillations of Generators in Parallel and Compensation by Modern Indirect Governors (Das Pendeln parallel geschalteter Maschinen und die Kompensation bei modernen indirekten Regulatoren). Herr Kröner. A mathematical discussion of the governing of steam turbines driving alternators in parallel. Ills. Serial. 1st part. 3000 w. Zeitschr f d Gesamte Turbinenwesen—Oct. 10, 1910. No. 18776 D.

Turbine Rotors.

Recent Developments in Drum Rotors for Steam Turbines (Ueber neuere Lauftrommeln für Dampfturbinen). W. Gentsch. An illustrated review of recent types of construction. 4500 w. Die Turbine—Oct. 20, 1910. No. 18775 D.

Turbines.

The Modern Parsons Turbine. Brief review of important improvements since its advent in 1884. 2000 w. Engr, Lond—Nov. 11, 1910. No. 18686 A.

The Steam Turbine and its Applications (Sulla Turbina a Vapore e sulle sue Applicazioni). E. Peretti. A review of existing types, and of stationary and propulsive applications. Ills. Serial. 1st part. 3200 w. Ing Ferro—Oct. 16, 1910. No. 18739 D.

Turbine Troubles.

See Steam Turbines, under MARINE AND NAVAL ENGINEERING.

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TRANSPORTING AND CONVEYING.

Aerial Tramways.

Rapid Growth in the Use of Aerial Tramways. William Hewitt. Illustrates and describes applications of overhead transport. 600 w. Cassier's Mag—Nov., 1910. No. 18620 B.

Aerial Tramways for Blast-Furnace Charging (Die Verwendung der Elektrohängebahn zur Hochofenbegichtung). Hubert Hermanns. Illustrates a number of installations and describes their operation. 3000 w. Elektrotech u Maschinenbau—Oct. 30, 1910. No. 18914 D.

Conveyors.

A Wooden-Apron Conveyor Carrying Miscellaneous Freight from Wharf to Warehouse. Illustrated description of a conveyor performing this work at a Seattle wharf. 1000 w. Eng News—Nov. 10, 1910. No. 18452.

Coal-Conveyor at the Brussels Exhibition. Illustrated description. 1000 w. Engng—Oct. 28, 1910. No. 18496 A.

Handling Gravel Mechanically. H. H. Kress. Illustrates and describes appliances for conveying material. 800 w. Cassier's Mag—Nov., 1910. No. 18619 B.

Ore Handling.

The Mechanical Handling of Ores by Travelling Bridges Carrying a Revolving Car-Dumping Device (La Manutention mécanique des Minerais par des Ponts roulants culbuteurs a grand Rendement). Siegfried Lévi. Describes an installation for unloading mine cars at the de Landres iron mines in France. Ills. 1300 w. Génie Civil—Oct. 8, 1910. No. 18720 D.

Transporters.

2½-Ton Electric Transporter. Illustrations, with brief description of a transporter erected at Fleetwood Docks. 350 w. Engng—Nov. 18, 1910. No. 18992 A.

Electrical Equipment of Travelling Transporters (Elektrische Einrichtungen an fahrbaren Verladebrücken). O. Pollok. Describes the electrical operation of a number of ore and coal handling and storage plants. Ills. 2750 w. Zeitschr d Ver Deutscher Ing—Oct. 1, 1910. No. 18916 D.

See also Ore Handling, under TRANSPORTING AND CONVEYING.

MISCELLANY.

Gas Works.

Mechanical Engineering Problems in Illuminating Gas Works. J. A. P. Crisfield. Discusses problems in the design and operation of a gas works and their solution. Ills. 2500 w. Jour Fr Inst—Nov., 1910. No. 18699 D.

Glass Making.

Sievert's Mechanical Glass-Making Processes (Emploi des Procédés mécaniques Sievert en Verrerie). V. Bertrand. Describes the recently perfected processes of Paul Sievert, the products, etc. Ills. Serial. 1st part. 2500 w. Génie Civil—Oct. 8, 1910. No. 18721 D.

Guns.

Guns for Attacking Airships. From *Artilleristische Monatshefte.* An illustrated review of the present state of the problem and its peculiarities. 2200 w. Sci Am Sup—Nov. 12, 1910. No. 18459.

Kneading Machines.

Bread Making and Mechanical Kneaders (La Panification et les Pétrins mécaniques). J. A. Montpellier. Discusses mechanical kneaders from the point of view of hygiene, and describes various types. Ills. Serial. 1st part. 2500 w. Tech Mod—Sept., 1910. No. 18711 D.

Printing Machinery.

The Technology of Bank-Note Printing (Die technischen Anforderungen des Wertpapierdruckes). G. Nicolaus. A review of processes and apparatus for the printing of paper money. Ills. Serial. 1st part. 5800 w. Zeitschr d Ver Deutscher Ing—Oct. 22, 1910. No. 18924 D.

Sugar Machinery.

A Three-Roller Sugar-Cane Mill. Gavin A. Renton. Illustrated description. 2500 w. Mech Wld—Oct. 21 & Nov. 18, 1910. Serial. 2 parts. No. 18981 each A.

MINING AND METALLURGY.

COAL AND COKE.

Accidents.

Methods of Dealing with Fires, Explosions and Falls in Mines. From the presidential address of Alfred J. Tonge, at meeting of the Manchester Geol. & Min. Soc. Diagrams. 3500 w. Ir & Coal Trds Rev—Nov. 11, 1910. No. 18688 A.

Alabama.

Kellerman Mine, Kellerman, Ala. Neill Hutchins. Illustrated description of the methods of preparing the coal, and of transportation facilities. 3000 w. Mines & Min—Nov., 1910. No. 18329 C.

Alberta.

Annual Report of Department of Public Works of the Province of Alberta, Coal Mine Branch. Information concerning output, development, etc., of the different coal mining districts in the Province of Alberta. 6000 w. Can Min Jour—Nov. 1, 1910. No. 18414.

China.

The Pinghsiang Colliery. K. P. Swensen. An illustrated account of the development and methods at this Chinese mine. 3000 w. Min & Sci Pr—Oct. 29, 1910. No. 18363.

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Coal Cutting.

The Use of Coal Cutting Machinery. R. H. Rowland. Considers the advantages and disadvantages of the adoption of undercutting machines in mines. 3500 w. Eng & Min Jour—Nov. 26, 1910. No. 18950.

Coal Tar.

Coal Tar—Its Products and Uses. William W. Borman. Shows the economic importance of the coal tar industry. 6000 w. Pro St Louis Ry Club—Oct. 14, 1910. No. 18694.

Coke-Oven Linings.

The Destruction of Coke-Oven Linings (Ueber Koksofensteinzerstörungen und deren Ursachen). F. Schreiber. A discussion of the causes. Ills. 3000 w. Stahl u Eisen—Oct. 26, 1910. No. 18752 D.

Electric Power.

The Design of Mining Switchgear. G. M. Harvey. Brief discussion of points in design which need particular attention to secure safety, reliability and economy. 1200 w. Elec Rev, Lond—Nov. 11, 1910. No. 18674 A.

Proposed Rules for Use of Electricity in Mines. Gives rules recommended as a basis for the enactment of uniform legislation on electrical practice in mines. 8500 w. Min Wld—Nov. 26, 1910. Serial. 1st part. No. 18963.

Explosions.

Explosion at Palau No. 2 Mine. Discusses the extent and cause of the explosion. Ills. 2400 w. Mines & Min—Nov., 1910. No. 18328 C.

Handling.

A Coal-Loading Machine. William Whaley. Illustrated description of apparatus for use in mines to load coal cars. 1500 w. Mines & Min—Nov., 1910. No. 18330 C.

Kentucky.

The Elkhorn Coking Coal Field to Be Developed. Map and description, with information regarding the property. 4000 w. Mfrs' Rec—Nov. 10, 1910. No. 18420.

Mine Dust.

French Coal-Dust Experiments. M. Taffanel. Abstracted from reports by the Comité Central des Houillères de France. An account of the first and second series of experiments is given in this number. 1800 w. Col Guard—Oct. 21, 1910. Serial. 1st part. No. 18293 A.

Mine Laboratories.

Mine Laboratory Work at Gary, W. Va. Describes the equipment of the laboratory, and methods of sampling coal, coke, and mine air. Ills. 1600 w. Mines & Min—Nov., 1910. No. 18332 C.

Mine Roofs.

The Chemical Characteristics of the Roofs of Lignite and Bituminous Coal Seams (Zur chemischen Charakteristik der Hangendesteine von Braun- und Steinkohlen). A. Lissner. A report of an investigation of a large number of samples. Serial. 1st part. 2500 w. Oest Zeitschr f Berg- u Hüttenwesen—Oct. 15, 1910. No. 18758 D.

Mine Waters.

The Clarification of Mine Waters in the Ems District (Klärung von Zechenabwasser im Emschergebiet). Herr Müller. Describes plants for the clarification of washing water. Ills. 2000 w. Glückauf—Oct. 1, 1910. No. 18760 D.

Mining.

American vs. European Coal Mines. Henry M. Payne. Discusses points of difference in methods and conditions 2200 w. Mines & Min—Nov., 1910. No. 18326 C.

American Longwall Mining Methods. Henry M. Payne. Compares with the system as used in England, and gives an example of room-and-pillar operation converted into a longwall mine. 1600 w. Eng & Min Jour—Nov. 19, 1910. No. 18659.

Mining Costs.

The Rise in the Cost of Production. Isaac Hodges. Presidential address at meeting of Midland Inst. of Min., Civ., & Mech. Engrs. Discusses the increase of working costs in coal mines during the past-half century, the rate of increase and the causes. 3000 w. Col Guard—Nov. 18, 1910. No. 18990 A.

Mining Engineering.

Expert Engineering at Colliery. Alexander Anderson. Address before the Assn. of Min. Elec. Engrs. discussing the work of the colliery manager, consulting engineer, the manufacturer, and the colliery engineer. 3500 w. Ir & Coal Trds Rev—Nov. 18, 1910. No. 19003 A.

Oklahoma.

Coal Mining in Oklahoma. Willis P. Thomas. Information concerning the extent of development, quality of the coal, methods of mining, hauling, and preparing. Ills. 2200 w. Mines & Min—Nov., 1910. No. 18325 C.

Philippines.

Philippine Coal. Warren D. Smith. Illustrated article, giving maps and description of mines now in operation, and the location of other deposits, their quality, etc. 2000 w. Far East Rev—Sept., 1910. No. 18639 N.

Picking.

See Washing, under COAL AND COKE.

Rescue Methods.

First-Aid Contests. An illustrated account of the annual contests by teams of the different collieries of the Pennsylvania anthracite region. 4000 w. Mines & Min—Nov., 1910. No. 18327 C.

Rescue Stations.

Rescue Stations in Illinois Coal Mining Localities. R. Y. Williams. Considers the design and equipment, the character of the training, advantages, etc., general discussion. 10000 w. Jour W Soc of Engrs—Oct., 1910. No. 18834 D.

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Washing.

Coal Washing v. Picking. Illustrates and describes the Greaves coal washer, giving such information as will enable a comparison to be made of the relative values of picking and washing. 3000 w. Ir & Coal Trds Rev—Nov. 4, 1910. No. 18588 A.

Extensions to Plant at the Dean and Chapter Colliery. Illustrates and describes a "Luhrig" washery, supplying coal to 100 coke ovens, a recovery plant, etc. 1500 w. Ir & Coal Trds Rev—Oct. 28, 1910. No. 18507 A.

Coal-Washing Plant at the Bergmannsgluck Mine, Buer, Germany (Die Kohlenwäsche auf der Schachtanlage Bergmannsgluck der Kgl. Berginspektion 3 in Buer i. W.). M. Hirsch. Illustrated description of the leading features of the plant. Sections of the washery. 2400 w. Glückauf—Oct. 29, 1910. No. 18765 D.

See also Mine Waters, under COAL AND COKE.

COPPER.

Alaska.

Chitins Copper Region in Southern Alaska. L. W. Storm. Explains the present conditions, describing location, deposits, etc. Map. 2500 w. Eng & Min Jour—Nov. 19, 1910. No. 18656.

Arizona.

Copper Deposits of Northern Yuma County. Edwin Higgins. Describes the region, the deposits, and their development. Map. 2500 w. Min Wld—Nov. 5, 1910. Serial. 1st part. No. 18410.

Blast-Furnace Charges.

A Smelting Charge Calculator. Illustrated description of Balling's new instrument. 800 w. Sci Am Sup—Nov. 12, 1910. No. 18462.

Bolivia.

Bedded Copper Deposits of Carangas, Bolivia. Robert Hawxhurst, Jr. Describes ore-bearing strata 600 ft. thick and outcrops for two miles. Mining conditions favorable. Ills. 3000 w. Eng & Min Jour—Nov. 5, 1910. No. 18402.

Hydrometallurgy.

The Outlook for Hydrometallurgy of Copper. William E. Greenawalt. Discussion of the limitations of smelting processes, difficulties of the wet methods and present processes. 4000 w. Eng & Min Jour—Nov. 12, 1910. No. 18520.

The Greenawalt Electrolytic Process. William E. Greenawalt. Describes this process in which the copper is dissolved by dilute acid chloride solutions, and then precipitated by electrolysis, etc. 5000 w. Eng & Min Jour—Nov. 26, 1910. No. 18899.

Mexico.

Mining Methods Employed at Cananea, Mex. Morris J. Ensing. Reports the geological and labor conditions, describing methods. Ills. 3500 w. Eng & Min Jour—Nov. 5, 1910. Serial. 1st part. No. 18403.

Mines of Zomelahuacan, Veracruz, Mexico. Martin Fishback. Illustrated account of a district having a large area of low-grade sulphide ore. 2000 w. Eng & Min Jour—Nov. 19, 1910. No. 18658.

Nevada.

Fourth Annual Report of Nevada Consolidated. Gives the report practically in full. Ills. 2000 w. Eng & Min Jour—Nov. 19, 1910. No. 18654.

Prospecting.

See same title, under MINING.

Slag.

Lead and Copper Slags. James A. Barr. Information concerning slags, the effect of slag constituents, and related data. 2500 w. Min & Sci Pr—Nov. 5, 1910. No. 18537.

Smelters.

A Small Modern Copper-Smelting Plant. Charles C. Christensen. Mathematical determination of a furnace of stated capacity. 2500 w. Min Wld—Nov. 26, 1910. No. 18959.

The New International Smelter at Tooele, Utah. Leroy A. Palmer. Illustrated description of the plant and its equipment. 3500 w. Min Wld—Nov. 19, 1910. No. 18671.

The International Smeltery at Tooele, Utah. C. H. Repath and A. G. MacGregor. Abstract of paper read before the Utah Soc. of Engrs. Illustrates and describes the smelter and its operation. 1200 w. Eng & Min Jour—Nov. 26, 1910. No. 18898.

Tennessee.

The Work of the Tennessee Copper Company. Karl R. Morgan. Describes methods of mining and smelting and other features. 2800 w. Min & Sci Pr—Nov. 19, 1910. No. 18938.

GOLD AND SILVER.

Australia.

The Gold Mining Industry of Victoria. A critical discussion of the present conditions and opportunities for improvement. 3500 w. Aust Min Stand—Oct. 5, 1910. No. 18599 B.

British Columbia.

Portland Canal Mining District, British Columbia. Newton W. Emmens. An illustrated description of the country and its geology, and briefly reviewing its history. 2200 w. Min Wld—Nov. 12, 1910. Serial. 1st part. No. 18544.

Cobalt.

The Rehabilitation of the La Rose Con. Mines. Alex. Gray. A report of the present condition of these Cobalt silver mines. 3000 w. Min Wld—Oct. 29, 1910. No. 18261.

See also Prospecting, under MINING.

Colorado.

Mining in the San Juan. William H. Storms. An account of present condi-

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tions as observed during a recent visit. Ills. 2500 w. Min & Sci Pr—Nov. 5, 1910. Serial. 1st part. No. 18539.

Mining in the Silverton Quadrangle, Colorado Arthur Lakes Illustrated description of the geology and mining development of this region 2000 w. Min Wld—Nov. 5, 1910. No. 18412.

Cyaniding.

Modified Cyanide Process. A description of the process of Mr. John Collins Clancy, in which calcium cyanamide is substituted in part or entirely for sodium cyanide and potassium cyanide. Electrolysis plays an important part. Also editorial. 6000 w. Met & Chem Engng—Nov., 1910. No. 18441 C.

French Guiana.

The Gold Fields of French Guiana and the New Method of Dredging. Albert F. J. Bordeaux. History and illustrated description of the coutnry and conditions, the geology, placers, dredging methods, costs, etc. 8800 w. Bul Am Inst of Min Engrs—Nov., 1910. No. 18836 F.

Gold Coast.

The Gold Coast: The "Sick Man" of the Mining Industry. Joseph Ralph. Explains conditions, discussing the climate, labor, etc. 7500 w. Min Jour—Oct. 22, 1910. Serial. 1st part. No. 18290 A.

Nevada.

National, Nevada. H. C. Cutler. Describes the geology, present development, and promise of the camp. Ills. 1500 w. Min & Sci Pr—Nov. 5, 1910. No. 18538.

Ontario.

The Porcupine Goldfield. A. L. Simon. Map and illustrated description of the district and its development. 2200 w. Mining Mag—Nov., 1910. No. 18947 B.

Porcupine Gold Deposits. Reginald E. Hore. Illustrated description of the deposits of this promising region. 1700 w. Can Min Jour—Nov. 1, 1910. No. 18413.

Placers.

Mining Cement Gravel at Altar, Mexico. Illustrates and describes old and new methods of recovering gold from cemented gravel in absence of water. 1800 w. Mines & Min—Nov., 1910. No. 18334 C.

See also Siberia, under GOLD AND SILVER.

Siberia.

Native Methods in Siberia. Fred L. Lowell. Illustrates and describes working methods used by Russians, Chinese and Koreans in the placer mining regions of eastern Siberia. 1500 w. Min & Sci Pr—Nov. 5, 1910. No. 18536.

IRON AND STEEL.

Analysis.

Analysis of Titaniferous Iron Ores. W. D. Brown. Explains the method of analysis used by the writer. 2000 w. Met & Chem Engng—Nov., 1910. No. 18439 C.

Standardization of Permanganate Solutions in the Reinhardt Titration Method (Titerstellung von Kaliumpermanganatlösungen zur Eisentitration nach Reinhardt). A criticism by Dr. L. Brandt of a paper in *Stahl und Eisen* for March 9, 1910, with a reply by the author. 4500 w Stahl u Eisen—Oct. 26, 1910. No. 18753 D.

Blast-Furnace Accidents.

Preventable Blast Furnaces Accidents. R. H. Sweetser. Brief discussion of methods of guarding against explosions of "normal" gas and blowing-in gas. 2500 w. Ir Age—Nov. 3, 1910. No. 18321.

Blast-Furnace Gas.

The Origin of the Hydrogen in Blast-Furnace Gas (Die l'Origine de l'Hydrogène dans les Gaz de Hauts-Fourneaux). Henry Le Chatelier. Proposes a simple theory based on the results of Wysor and Brown. 1000 w. Rev de Métal—Oct., 1910. No. 18701 E + F.

See also Central Stations, under ELECTRICAL ENGINEERING, GENERATING STATIONS; and Gas Power Plants, under MECHANICAL ENGINEERING, COMBUSTION MOTORS.

Blast Furnaces.

New Furnace B—Detroit Iron & Steel Co. Illustrated description of recent extensions which have doubled the capacity of the plant. 1200 w. Ir Trd Rev—Nov. 17, 1910. No. 18632.

Blowers.

An Electrically Driven Blowing Engine. Illustrates and describes a vertical blast furnace blowing engine at Ormesby Iron Works, driven by electricity. 600 w. Engr, Lond—Oct. 21, 1910. No. 18305 A.

The Schleifmühle Blowers (Gebläsemaschine Schleifmühle). Describes the gas-driven blast-furnace and steel-works blowers built by Ehrhardt & Sehmer. Ills. 2000 w. Elektrotech Rundschau—Oct. 13, 1910. No. 18901 D.

See also Gas Power Plants, under MECHANICAL ENGINEERING, COMBUSTION MOTORS; and Turbo-Compressors, under MECHANICAL ENGINEERING, POWER AND TRANSMISSION.

Cuba.

Iron Ores of Santiago, Cuba. E. B. Wilson. Illustrated account of the location and extent of the deposits, methods of mining and transportation. 4000 w. Mines & Min—Nov., 1910. No. 18336 C.

Dry-Air Blast.

Saving in Fuel and Increase in Production through the Use of Dried and Heated Blast (Ueber die Ursachen der Brennstoffesparnis und der Mehrerzeugung beim Hochofenbetrieb durch die Verwendung erhitzten und getrockneten Windes). F Wüst. Read at the Düsseldorf Congress. A review of practical results of the Gayley process. Ills. 4200 w. Stahl u Eisen—Oct. 5, 1910. No. 18746 D.

Electrometallurgy.

Notes on the Electro-Metallurgy of Iron and Steel. T. R. Loudon. Illustrated ex-

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planation of the working of some of the furnaces used in the electro-thermic reduction of iron ore and the production of steel. 3000 w. Ap Sci—Nov., 1910. No. 18819 C.

Progress in the Electrometallurgy of Iron and Steel. James Aston. Brief review of the development and of applications made. 1500 w. Wis Engr—Nov., 1910. No. 18826 C.

A New Electric Arc Process for Producing and Refining Steel. Frank C. Perkins. Drawings and description of a new process consisting of the use of composite or combination electrodes producing arcs. 2200 w. Can Min Jour—Nov. 15, 1910. No. 18651.

The Keller Electric Steel Furnace at the F. Holtzer Steel Works, Unieux (Der Elektrostahlofen, System Keller, der Aciéries F. Holtzer in Unieux). A detailed and fully illustrated description of the installation. Serial. 1st part. 600 w. Elektrochem Zeitschr—Oct., 1910. No. 18744 D.

France.

Iron Mining in the Norman Basin (L'Extraction du Minerai de Fer dans le Bassin Normand). S. Brull. Describes mining and hoisting practice at the Larchamp mines, Orne. Ills. 2300 w. Génie Civil—Oct. 15, 1910. No. 18720 D.

Germany.

German Competition in Iron and Steel. Discusses the results of the German bounties and the effect on British exports. 1800 w. Engr, Lond—Nov. 18, 1910. No. 18996 A.

Great Britain.

Presidential Address before the West of Scotland Iron and Steel Institute, William Clark. A short review of the past and present of the iron and steel industry. 3500 w. Jour W of Scotland Ir & St Inst—Oct., 1910. No. 19006 N.

The British Steel Makers' Ore Supplies: With Some Considerations Respecting Our Future Requirements. W. H. Herdsman. Remarks on the origin of iron ores, and discussion of the low phosphorus ore supplies, the phosphorus, and the manganese ores, etc. 5500 w. Jour W of Scotland Ir & Steel Inst—Oct., 1910. No. 19005 N.

Industry.

See Germany, and Great Britain, under IRON AND STEEL.

Ore Resources.

The Supply of Iron. James F. Kemp. Contribution to a discussion before the Int. Geol. Cong. Discusses the world's probable reserves of iron ore. 3000 w. Mining Mag—Nov., 1910. No. 18964 B.

Rolling Mills.

Rolling Mill Machinery. Abstract translation of an article by H. Ortmann, in *Stahl und Eisen*, on the improvements made in construction during the last ten years. Ills. 2000 w. Ir Age—Nov. 10, 1910. No. 18431.

Continuous Roll Trains (Zur Frage der kontinuierlichen Walzenstrassen). E. Gerbracht. A statement of their advantages in safety and economy of operation. Ills. 2000 w. Stahl u Eisen—Oct. 19, 1910. No. 18749 D.

The Calibration of Rolls for Channel Sections (Die Anordnung der Stauchkaliber für [-Profile). L. Schaefer. A reply to a criticism of a previous paper of the author by Herr Tafel, in *Stahl und Eisen* for May 19, 1909. Ills. 2000 w. Stahl u Eisen—Oct. 26, 1910. No. 18751 D.

An Investigation of the Pressure Exerted by Blooming Rolls (Versuche über Walzdrucke an einem Blockwalzwerk). J. Puppe. A detailed report of an extended investigation by the German commission on the power requirements of rolling mills. Ills. Serial. 1st part. 6800 w. Stahl u Eisen—Oct. 26, 1910. No. 18750 D.

LEAD AND ZINC.

Australia.

Burketown Mineral Field. Lionel C. Ball. Advance report on the Queensland silver-lead and zinc mines. Ills. 5000 w. Queens Gov Min Jour—Oct. 15, 1910. No. 18673 B.

Germany.

The Silver Content of the Lead Ores of the Deutz-Ründeroth District (Der Silbergehalt der Bleierze in den Gängen des Bergreviers Deutz-Ründeroth). Eugen Schulz. Discusses the variations in the percentage of silver over a long period of years. Serial. 1st part. 5200 w. Glückauf—Oct. 1, 1910. No. 18759 D.

Lead Assaying.

Electrolytic Determination of Lead in Ores. R. C. Benner and W. H. Ross. Explanation of method, with statement of results. 1300 w. Min & Sci Pr—Nov. 12, 1910. No. 18637.

Lead Pigments.

The Manufacture of Sublimed White Lead. J. I. Blair. Illustrates and describes a process used by only two plants in the United States, producing a basic lead sulphate. 1800 w. Eng & Min Jour—Nov. 5, 1910. No. 18401.

Lead Slag.

See Slag, under COPPER.

Scotland.

Lead Mining in Scotland. Editorial, giving information concerning this industry and the important developments in progress. 2200 w. Engng—Nov. 4, 1910. No. 18576 A.

Tennessee.

The Zinc Mining Industry of Tennessee. Samuel W. Osgood. Abstracted from Bul. No. 2, Tenn. Geol. Surv. Illustrated description of the zinc district, the ores, past and present methods of mining, etc. 2500 w. Min Wld—Nov. 26, 1910. No. 18960.

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MINOR MINERALS.

Aluminium.

The British Aluminium Company's Works at Kinlochleven, Argyllshire. A. A. H. Scott. Remarks on the mechanical properties of aluminium, methods of working, etc., describing the industry and metallurgical practice in the West Highlands of Scotland. 2000 w. Jour Inst of San Engrs—Oct., 1910. No. 18551 B.

Calcium Sulphate.

The Reduction of Calcium Sulphate by Carbon Monoxide and Carbon, and the Oxidation of Calcium Sulphide. H. O. Hofman. Deals with the behavior of calcium sulphate under reducing conditions, and the changes the calcium sulphide formed undergoes when subjected to an oxidizing roast. 7000 w. Bul Am Inst of Min Engrs—Nov., 1910. No. 18837 F.

Cement.

The Manufacture of Portland Cement. J. Ralph Bolgiano. Illustrated description of methods and appliances used. 2000 w. Sib Jour of Engng—Oct., 1910. No. 18311 C.

Combustion in Cement Burning. Discussion of Mr. Eldred's paper. 2200 w. Bul Am Inst of Min Engrs—Nov., 1910. No. 18839 F.

Portland Cement Works in Sweden. Illustrated description of the Shanska works and the methods used. 3300 w. Engr, Lond —Oct. 28, 1910. No. 18501 A.

Monazite.

Sources and Production of Monazite and Zircon. Douglas B. Sterrett. Abstracted from Min. Resources of the U. S., 1910. Principally, information concerning monazite, which is in demand to supply thorium for the manufacture of gas mantles. 4500 w. Min Wld—Oct. 29, 1910. No. 18260.

Oil.

Occurrence of Oil and Gas. William Forstner. A study of the California deposits. 4500 w. Min & Sci Pr—Nov. 12, 1910. No. 18636.

A Review of the Oil Situation in California. A. H. Martin. Information concerning production, development, etc., giving a hopeful outlook. 1800 w. Min Wld—Nov. 5, 1910. No. 18411.

The Manufacture of Petroleum Lubricating Oils. Paul W. Prutzman. Describes the drilling and pumping of crude oil, the distillation, and refining. 2500 w. Min Wld —Oct. 29, 1910. No. 18262.

Maikop: The Position To-day. E. de Hautpick. Describes the work done and in progress in this Russian petroleum region. 3000 w. Min Jour—Nov. 5, 1910. No. 18565 A.

Platinum.

Government Monopoly of Russian Platinum Industry. E. de Hautpick. A report of the Ural platinum industry. 1000 w. Min Jour—Nov. 5, 1910. No. 18566 A.

Silicon.

The Production of Silicon Compounds (Neuerungen auf dem Gebiete der Siliciumverbindungen). S. Herrmann. Describes the Baraduc-Muller processes of producing metallic silicides and carbosilicides. Serial. 1st part. 1500 w. Elektrochem Zeitschr—Oct., 1910. No. 18743 D.

Tin.

Tin Mining and Milling in the Bolivian Andes. George W. Dean. Illustrated article describing the crude methods employed. 2000 w. Eng & Min Jour—Nov. 26, 1910. No. 18895.

Tungsten.

Occurrence of Tungsten in Rand District, Cal. Samuel H. Dolbear. Information concerning the deposits, methods employed, tests, etc. 2000 w. Eng & Min Jour—Nov. 5, 1910. No. 18400.

Zircon.

See Monazite, under MINOR MINERALS.

MINING.

Drainage.

The Cripple Creek Drainage Tunnel, Colorado. A. W. Warwick. Explains how the Roosevelt tunnel has been driven and what it is intended to accomplish. Ills. 3500 w. Min Wld—Nov. 26, 1910. No. 18958.

Earth Settlement.

Earth Settlement in Mining Districts (Beiträge zur Bergschädenfrage). Herr Fromme. A discussion of the dangers of buildings located over mine workings. Ills. 2500 w. Glückauf—Oct. 8, 1910. No. 18761 D.

Education.

See same title, under INDUSTRIAL ECONOMY.

Electric Hoisting.

Electric Hoisting in Mining Operations. S. F. Walker. Discusses the gradual replacing of the steam hoist by electric systems, giving brief descriptions of some of them. Ills. 2500 w. Eng & Min Jour—Nov. 19, 1910. No. 18657.

Explosives.

Blasting Supplies. F. H. Gunsolus. On the importance of proper apparatus for firing and detonating explosives. Ills. 3800 w. Mines & Min—Nov. 1910. No. 18333 C.

Floods.

Danger of Inrushes of Surface Water. Explains the need of thick covers above mines liable to surface floods. 1000 w. Eng & Min Jour—Nov. 12, 1910. No. 18522.

Haulage.

Haulage Gears for Mines. Illustrated description of a modern example of haulage installations. 1200 w. Engng—Nov. 18, 1910. No. 18994 A.

Hoisting Engines.

The Caledonia Cut-Off Gear for Winding Engines. Illustrated description of the gear and its action. 1500 w. Col Guard—Nov. 4, 1910. No. 18573 A.

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Corliss Winding Engines. Illustrated description of engines recently erected at the Fryston Colliery. Also illustrates and describes the Notbohm-Eigemann safety apparatus for the prevention of overwinding. 1000 w. Engr, Lond—Oct. 28, 1910. No. 18506 A.

Mine Cars.

Car Coupling Devices in Use in the Mines in the Rhine-Westfalia District, Germany (Die auf den Zechen des rheinischwestfälischen Industriebezirks gebrauchlichen Vorrichtungen zur Verbindung des Förderwagen). Oskar Schulz. Describes a number of devices. Ills. 3200 w. Glückauf—Oct. 22, 1910. No. 18764 D.

Mine Locomotives.

Underground Electric Gathering Locomotives. Frank C. Perkins. Illustrates and describes the Jeffrey conductor cable reel gathering locomotive. 1500 w. Min Wld—Nov. 26, 1910. No. 18961.

Mine Tracks.

An Automatic Signal System for Crossovers on Underground Railways Operated by Electric Locomotives (Selbsttätige Signalvorrichtung zur Sicherung des Betriebes elektrischer Lokomotiven in Kreuzungstellen unter Tage). Herr Mayer. Describes an installation in a German coal mine. Ills. 1500 w. Glückauf—Oct. 15, 1910. No. 18762 D.

Mining Law.

Recent Mining Legislation in the Kingdom of Saxony (Die neuzeitliche Berggesetzgebung im Königreich Sachsen). G. Stein. Discusses particularly the sections relating to mine accidents. Serial. 1st part. 7500 w. Glückauf—Oct. 29, 1910. No. 18766 D.

Placer Mining.

The Drag Line Excavator. J. Power Hutchins. Illustrated description of this new machine and its operation, explaining its advantages in placer mining. 2000 w. Mining Mag—Nov., 1910. No. 18949 B.

Prospecting.

Prospecting Disseminated Copper Ore Deposits. Charles R. Keyes. Shows that a study of geological conditions is essential and new methods of prospecting. 2000 w. Eng & Min Jour—Nov. 26, 1910. No. 18896.

Prospecting in the Cobalt District. H L. Batten. Discusses the work to be performed after the claim is staked, to determine the value of the property, position of veins, etc. 2500 w. Ap Sci—Nov., 1910. No. 18820 C.

Prospects.

The Difference Between a Prospect and a Mine. Francis C. Nicholas. An explanation. 2500 w. Min Wld—Nov. 26, 1910. No. 18962.

Shaft Lining.

Reinforced Concrete in Mining (Eisenbeton unter Tage). F. Baumstark. The first part discusses the lining of shafts and shaft stations. Ills. Serial. 1st part. 1700 w. Beton u Eisen—Oct. 27, 1910. No. 18798 F.

Shafts.

A Concrete Shaft at Tower, Minnesota. P. F. Chamberlain. Detailed description of work on the property of the N. American Iron Mining Co., made necessary by the great amount of water. Ills. 1500 w. Eng Rec—Nov. 12, 1910. No. 18516.

Shaft Sinking.

A Study of the Freezing Process (Versuche und Studien über das Gefrierverfahren). W. Walbrecker. A detailed examination of the freezing process in shaft sinking. Ills. Serial. 1st part. 4800 w. Glückauf—Oct. 22, 1910. No. 18763 D.

Tunnels.

See Drainage, under MINING; and Tunnels, under CIVIL ENGINEERING, CONSTRUCTION

ORE DRESSING AND CONCENTRATION.

Chilean Mills.

Some of the Characteristics of Chilean Mills. Herbert A. Megraw. Explains the original purpose of the Chilean mill, the changes in modern mills and the advantages. 2500 w. Eng & Min Jour—Nov. 12, 1910. No. 18521.

Crushing.

See Rock Crushing, under CIVIL ENGINEERING, MUNICIPAL.

Electrostatic Separation.

Electrostatic Separation. Henry A. Wentworth. Explains the difference in principle between electrostatic and magnetic separation. 1500 w. Min & Sci Pr—Oct. 29, 1910. No. 18364.

Sampling.

The Element of Chance in the Sampling of Ores. Lewis T. Wright. A study of the magnitude of the element of chance in sampling ores. 4500 w. Mining Mag—Nov., 1910. No. 18948 B.

Stamp Mills.

Notes on Battery Practice. A. R. Stackpoole. Short paper on stamp mill accessories, with discussion. Ills. 3200 w. Jour Chem, Met, & Min Soc of S Africa—Sept., 1910. No. 18555 E.

Tin Milling.

See Tin, under MINOR MINERALS.

Tube Mills.

The Problem of Fine Grinding in Tube Mills. H. W. Hardinge. Discusses the inefficiency of tube mills, and some of the problems of fine crushing. 1200 w. Eng & Min Jour—Nov. 26, 1910. No. 18897.

MISCELLANY.

Argentina.

Mining in the Argentine. Charles Janin. Map and general information. 1700 w. Min & Sci Pr—Oct. 29, 1910. No. 18365.

Canada.

The Department of Mines of Canada. Its Organization and Its Work. Alfred W. G. Wilson. A statement of the pres-

ent organization and functions of the department, with a brief historical sketch. 4000 w. Ec-Geol—Nov., 1910. No. 18623 D.

Colorado.

Scope and Progress of the Mining Industry in Colorado. Prepared by the Faculty of the Colorado Sch. of Mines. A review of recent development, the range of metals and minerals, etc. 10000 w. Colo Sch of Mines Qr—Oct., 1910. No. 18308 N.

Status of Mining and Smelting in Colorado. Franklin Guiterman. Address before the Denver Chamber of Commerce. The decrease in gold, silver, and lead production is considered. 2500 w. Eng & Min Jour—Nov. 19, 1910. No. 18655.

Mining and Smelting Industries in Colorado. Franklin Guiterman. Abstract of paper read before the Denver Chamber of Mines. Discusses present conditions and some causes of the decline. 2500 w. Min Wld—Nov. 19, 1910. No. 18672.

Japan.

Mineral Resources of the Japanese Empire. Dr. A. Selwyn-Brown. Reviews the present and future outlook of the mineral industries, discussing general conditions, mining law, methods and machinery, copper and gold output. Ills. 3300 w. Engineering Magazine—Dec., 1910. Serial. 1st part. No. 18941 B.

Mineralogy.

Guide to the "Sight Recognition" of Seventy Important Minerals. A. J. Moses. Aims to give information that will aid in identification. 9000 w. Sch of Mines Qr—July, 1910. No. 18626 D.

Nicaragua.

Promising Mining Conditions in Nicaragua. T. Lane Carter. Map and illustrated description of mining conditions and development. 2500 w. Min Wld—Nov. 5, 1910. No. 18409.

Ore Deposits.

Structure and Origin of the Magnetite Deposits Near Dillsburg, York County, Pennsylvania. E. C. Harder. Maps and description of the ore deposits and mines, the rocks, and minerals. 7000 w. Ec-Geol—Nov., 1910. No. 18622 D.

RAILWAY ENGINEERING.

CONDUCTING TRANSPORTATION.

Communication.

See Radiotelegraphy, under ELECTRICAL ENGINEERING, COMMUNICATION.

Signalling.

The Safety of Railway Trains (Die Mitwirkung des Eisenbahnzuges zu seiner Sicherung). Herr Bardtke. A review of automatic signalling apparatus. Ills. Serial. 1st part. 6000 w. Glasers Ann—Oct. 15, 1910. No. 18782 D.

New Railway Safety Apparatus (Neue Apparate zur Sicherung des Bahnbetriebes). A. Tobler. Describes a new electric signalling installation at Locle station on the Jura-Neuchâtel line. Ills. 3600 w. Schweiz Bau—Oct. 1, 1910. No. 18769 B.

The Application of Interlocking to the Lartigue Electric Semaphore (L'Application des Enclenchements de Continuité à l'Electro-Sémaphore Lartigue). Ch. Jullien. Describes the original Lartigue apparatus and the modifications which have been recently introduced. Ills. 4000 w. Rev Gen d Chemins de Fer—Oct., 1910. No. 18707 G.

MOTIVE POWER AND EQUIPMENT.

Air Brakes.

Calculating Air Pressures. Deals with calculations to determine approximately the amount of free air required to charge a reservoir to different gauge pressures, and various variations of pressure. 2500 w. Ry & Loc Engng—Nov., 1910. No. 18319 C.

Car Oscillations.

The Oscillations of a Beam on Spring Supports and Their Application to the Investigation of Railway Rolling Stock (Die Schwingungsgleichungen des Balkens auf federnden Stützen und ihre Anwendung auf die Untersuchung von Fahrzeugen). J. Jahn. A mathematical study of car and locomotive oscillations based on a study of beams on spring supports. Ills. Serial. 1st part. 7800 w. Glasers Ann—Oct. 1, 1910. No. 18781 D.

Car Painting.

Protection of Metal Equipment. William Marshall. Introductory paper and general discussion giving much information on this subject. 20000 w. Pro N Y R R Club—Oct. 21, 1910. No. 18668.

Car Painting.

Car Trucks with Tapered Plate Centering Springs on the Midi Railway (Note sur les Bogies de Voitures à Ressorts de Rappel à Lames étagées de la Compagnie de la Chemins de Fer du Midi). M. Bachellery. Brief description with detailed drawings. 1200 w. Rev Gen d Chemins de Fer—Oct., 1910. No. 18708 G.

Electrification.

Boston Electrification Problem. Abstract of the reports of the N. Y., N. H., & H. R. R. and of the B. & A. R. R. relating to the electrification of all steam railroads within the Boston district. 3500 w. Elec Ry Jour—Nov. 19, 1910. No. 18635.

Locomotive Boilers.

Locomotive Boilers. Review of reports presented at the railway congress which

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show a lack of uniformity in practice. 5000 w. Am Engr & R R Jour—Nov., 1910. No. 18423 C.

Experimental Investigation of Inequalities of Expansion in Locomotive Boilers. An illustrated account of experiments made on the New York Central railroad to discover the cause of cracked plates and broken staybolts. From an address by D. R. MacBain before the N. Y. R. R. Club. 2500 w. Eng News—Nov. 3, 1910. No. 18350.

Locomotive Design.

A Note on Locomotive Design (Beitrag zur Berechnung von Lokomotiven). Rud. Engel. Describes simple graphical methods for certain fundamental calculations. Ills. 2000 w. Zeitschr d Ver Deutscher Ing—Oct. 22, 1910. No. 18927 D.

Locomotive Disconnecting.

Observations on Disconnecting. F. P. Roesch. A critical discussion of locomotive disconnecting practice. 2200 w. Ry & Loc Engng—Nov., 1910. No. 18318 C.

Locomotive Fireboxes.

Overheating and Pressure Test of a Jacobs-Shupert Locomotive Firebox. Reports a test made by the A., T. & S. F. Ry. to determine the strength and behavior under severe conditions. Ills. 1400 w. Eng News—Nov. 3, 1910. No. 18352.

Test of Jacobs-Shupert Firebox. Report of test made by the Santa Fe, at Topeka, Kan. on Sept. 26, 1910. Ills. 2500 w. Ry Age Gaz—Nov. 18, 1910. No. 18642.

New Locomotive Water-Tube Fire-Box. Drawings and information concerning a water-tube fire-box on a locomotive in service on the Chemen de Fer du Nord, and its performance. 1000 w. Engr, Lond—Nov. 4, 1910. No. 18582 A.

Locomotive Injectors.

Injectors. Their Defects and Remedies. Editorial letter, calling attention to injector troubles found in the lifting type of injector. 1100 w. Ry & Loc Engng—Nov., 1910. No. 18317 C.

Locomotives.

The Standardization of Locomotives in India, 1910. Cyril Hitchcock. Reviews the progress of locomotive standardization in India, noting features of the design, and materials employed. Ills. 5500 w. Inst of Mech Engrs—Oct. 21, 1910. No. 18490 N.

Steam Locomotives at the Brussels Exposition (Le Locomotive a Vapore all' Esposizione internazionale di Bruxelles 1910). I. Valenziani. A detailed review of the exhibits. Ills. Serial. 1st part. 5600 w. Ing Ferro—Oct. 1, 1910. No. 18737 D.

French Locomotives at the Brussels Exposition (Les Locomotives françaises a l'Exposition de Bruxelles). Brief descriptions of the various types exhibited, with plates and detailed drawings. Ills. Serial. 1st part. 2200 w. Rev Indus—Oct. 15, 1910. No. 18717 D.

Converted Mallet Locomotives for the Chicago Great Western. Illustrated detailed description of locomotives converted from the Prairie type to Mallet compounds. 1000 w. Ry Age Gaz—Nov. 4, 1910. No. 18372.

Mallet Articulated Compound Locomotive of the 2-8-8-2 Type. Illustrated description of an engine for the Virginian Ry., guaranteed to haul 20 cars weighing 28 tons each, with a caboose, up a 2.07 per cent. grade. 600 w. Am Engr & R R Jour—Nov., 1910. No. 18424 C.

Mallet Compound Locomotives for the Chesapeake & Ohio Ry. Illustrated description of a type of locomotive for heavy freight service. One of 24 engines ordered. 1400 w. Ry & Engng Rev—Nov. 5, 1910. No. 18437.

Engines for the St. Louis South-Western. Illustrates and describes engines of the 4-6-0 and 2-0-8 types, fitted with Walschaerts valve gear. 1200 w. Ry & Loc Engng—Nov., 1910. No. 18316 C.

Pacific and Consolidation Type Locomotives. Illustrates and describes powerful freight and passenger locomotives designed and built by the Chicago, Milwaukee & St. Paul Ry. 1200 w. Am Engr & R R Jour—Nov., 1910. No. 18429 C.

Suburban Tank Locomotive 4-6-4 Type. Illustrated description of an engine designed and built by the Canadian Pacific Ry. 2000 w. Am Engr & R R Jour—Nov., 1910. No. 18427 C.

Locomotive Stokers.

Mechanical Stokers for Locomotives. S. L. Yerkes. Brief consideration of the various types, followed by general discussion. 9000 w. Pro So & S-W Ry Club Sept., 1910. No. 18695 D.

Locomotive Valve Gears.

The Improved Baker-Pilliod Valve Gear. Illustrated detailed description. 1500 w. Am Engr & R R Jour—Nov., 1910. No. 18428 C.

Motor Cars.

See Oil Engines, under MECHANICAL ENGINEERING, COMBUSTION MOTORS.

Train Lighting.

Electric Car Lighting. D. F. Crawford. Brief consideration of the various systems, the recent development, and their applicability to the conditions to be met. 4500 w. Yale Sci M—Nov., 1910. No. 18627 C.

NEW PROJECTS.

Grand Trunk Pacific.

The National Trans-Continental Railway of Canada. Information concerning the railway under construction to connect the Atlantic and Pacific, which is entirely on British territory. A review of recent progress. 1200 w. Engr, Lond—Nov. 4, 1910. No. 18580 A.

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Idaho & Washington.

The Idaho & Washington Northern. Map and illustrated description of a line through valuable timber lands and mining districts of the far west. 2000 w. Ry Age Gaz—Nov. 18, 1910. No. 18641.

PERMANENT WAY AND BUILDINGS.

Embankment Protection.

Methods of Bank Protection. Report of a committee to the Am. Ry. Bridge & Bldg. Assn. Illustrates and describes methods to meet various conditions. 2500 w. Ry & Engng Rev—Nov. 5, 1910. No. 18436.

Logging Railways.

See Narrow Gauge, under PERMANENT WAY AND BUILDINGS.

Material Storage.

The New Material Storage Yard of the Holland Railway Company at Hilversum (De nieuwe Stapelplaatsen en houtbereidings-inrichting "Crailoo" van de Hollandsche IJzeren Spoorweg-Maatschappij te Hilversum). H. P. Maas Geesteranus. Describes a plant for the storage and handling of ties, rails, etc. Ills. 4600 w. De Ingenieur—Oct. 15, 1910. No. 18933 D.

Narrow Gauge.

The Logging Railways of the Pacific Northwest. Illustrates and describes railways built to bring timber out of the forests, and their equipment. 1500 w. Ry Age Gaz—Nov. 4, 1910. No. 18369.

Oil Houses.

Fireproof Oilhouses. Report of a committee to the Am. Ry. Bridge & Building Assn. on plans of fireproof oilhouses for storing large quantities of oil. Ills. 2000 w. Ry & Engng Rev—Oct. 29, 1910. No. 18264.

Ties.

Steel Ties and Wood Ties (Eisenschwelle und Holzschwelle). A summary of the controversy being waged in Germany over the relative merits of the two materials. 11200 w. Stahl u Eisen—Oct. 5, 1910. No. 18745 D.

Yards.

Gravity Freight Classification Yard for the Pennsylvania R. R. at Northumberland, Pa. W. A. MacCart. One of the largest freight classification yards on the Pennsylvania system operated by the hump or gravity method is illustrated and described. 2000 w. Engng News—Nov. 17, 1910. No. 18667.

TRAFFIC.

Commutation.

Rates and Cost of Commutation. Gives a chart made for the use of the N. Y., N. H. & H., discussing the information it gives. 700 w. Ry Age Gaz—Dec. 2, 1910. No. 19113.

Freight Rates.

Railway Rates and Railway Efficiency. Editorial discussion of the address by Louis T. Brandeis undertaking to show how the railways of the United States can reduce their operating expenses. 2500 w. Ry Age Gaz—Dec. 2, 1910. No. 19112.

Tonnage Charts.

Graphic Comparisons of Tonnage. F. A. Parker. Shows the usefulness of the graphic method of showing the condition of the volume and direction of business. 700 w. Ry Age Gaz—Nov. 18, 1910. No. 18643.

MISCELLANY.

England.

Transportation and Traffic in England. Logan G. McPherson. From a Preliminary Report to the Nat. Waterways Com. of the U. S. Historical review of the development. 4500 w. Ry Age Gaz—Nov. 25, 1910. Serial. 1st part. No. 18869.

Forest Fires.

Forest Fires and Railways. R. H. Campbell. Discusses fires due directly to railways, and Canadian railway acts relating to the subject. 3000 w. Can Engr—Nov. 17, 1910. No. 18652.

Great Britain.

The Earning Power of British Railways. General discussion of considerations affecting the prosperity of railways with tabulated statistics of gross and net earnings. 3800 w. Jour Soc of Arts—Oct. 21, 1910. Serial. 1st part. No. 18276 A.

International Congress.

The Significance and Results of the Eighth Session of the International Railway Congress (Ueber die Bedeutung und den Erfolg der achten Tagung des Internationalen Eisenbahn-Kongress-Verbandes). H. Dietler. A review of the work and permanent results of the recent meeting at Berne. 2200 w. Schweiz-Bau—Oct. 8, 1910. No. 18770 B.

Legislation.

The New Long and Short Haul Law. Discusses the power given to the Interstate Commerce Commission by this section of the Mann-Elkins act. 5500 w. Ry Age Gaz—Nov. 25, 1910. No. 18870.

The New "Commerce Court." Paul Synnestvedt. An explanation of the reasons for creating this court, its organization, special provisions and effect on the railroad situation generally. Discussion. 12500 w. Pro W Ry Club—Oct. 18, 1910. No. 18667 C.

Management.

Can the "Principles of Scientific Management" Be Applied to Railway Operation? Gives the substance of the address of Mr. Louis D. Brandeis before the Interstate Commerce Commission, with editorial comment. A critical discussion of the efficiency of railway operating in the United States. 2000 w. Eng News—Dec. 1, 1910. No. 19056.

See also Freight Rates, under TRAFFIC; and Wage Systems, under INDUSTRIAL ECONOMY.

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STREET AND ELECTRIC RAILWAYS.

Canal Haulage.

An Electrical Towing Installation on the Weser Canal at Bremen (Die elektrische Treidelei der Wehranlage für die Unterweserkorrektion bei Bremen). Otto Tuch. Illustrated description. 1800 w. Zeitschr d Ver Deutscher Ing—Oct., 1910. No. 18926 D.

Car Houses.

Recent Car House Construction in Chicago. Abstract from report of the Board of Sup.-Engrs., Chicago Traction, on principles of design and construction. 3000 w. Elec Ry Jour—Nov. 5, 1910. No. 18361.

Car Maintenance.

Car Maintenance Practice at Waltham, Mass. Illustrated detailed description of the system. 3000 w. Elec Ry Jour—Nov. 12, 1910. No. 18464.

Feeders.

Feeder Calculations for the Chicago Street Railways. Information from the second annual report, giving resolution adopted, and outlining the system of calculating the feeder requirements. 2000 w. Elec Ry Jour—Nov. 19, 1910. No. 18634.

Locomotive Headlights.

Discussion on "Headlight Tests." Jefferson, N. H., June 28, 1910. 3500 w. Pro Am Inst of Elec Engrs—Nov., 1910. No. 18846 F.

Locomotives.

Discussion on "The Design of the Electric Locomotive." Jefferson, N. H., July 1, 1910. The paper by N. W. Storer and G. M. Eaton is discussed. 7000 w. Pro Am Inst of Elec Engrs—Nov., 1910. No. 18849 F.

New Electric Locomotives for the Baltimore & Ohio Railroad. Illustrated description of two additional locomotives for service on the Baltimore belt line of the B. & O. R. R. 1400 w. Elec Ry Jour—Nov. 26, 1910. No. 18860.

A Swiss Accumulator Locomotive. Illustrated detailed description of an engine designed to meet stated conditions which has proved efficient in service. 1200 w. Tram & Ry Wld—Nov. 3, 1910. No. 18631 B.

An Electric Locomotive for the Wengernalp Railway, Switzerland (Locomotive électrique du Chemin de Fer de la Wengernalp, Suisse). Describes a novel locomotive for a rack railway. Ills. 1000 w. Génie Civil—Oct. 15, 1910. No. 18724 D.

Monorail.

The Monorail. Brief explanation of the theory and action of such cars, and statement of advantages claimed. 1000 w. Yale Sci M—Nov., 1910. No. 18629 C.

Physical Objections to the Scherl Monorail System (Physikalische Bedenken gegen die Einschienenbahn des Herrn Scherl). O. Martienssen. A criticism of certain fundamental parts of the system. Ills. 3000 w. Elek Kraft u Bahnen—Oct. 24, 1910. No. 18906 D.

Operation.

Discussion on "Power Economy in Electric Railway Operation—Coasting Tests on the Manhattan Railway, New York." Jefferson, N. H., July 1, 1910. H. St. Clair Putnam's paper is discussed. 3300 w. Pro Am Inst of Elec Engrs—Nov., 1910. No. 18850 F.

Rail Cleaning.

The Cleaning of Tramway Rails. A. Schörling. Abstract of a report describing the various apparatus and methods used. 1400 w. Elect'n, Lond—Nov. 4, 1910. No. 18564 A.

Rails.

The Composition and Manufacture of Tramway Rails and Rail Wear. Robert B. Holt. Illustrated discussion of the relation between rail wear and the composition and manufacture of the rails. 1700 w. Tram & Ry Wld—Nov. 3, 1910. No. 18630 B.

Rio de Janeiro.

The Corcovado Railway (Die Corcovadobahn). J. G. Boesch-Ouzelet. Detailed description of this line of the Rio de Janeiro Tramway, Light & Power Co. Ills. Serial. 1st part. 5200 w. Elek Kraft u Bahnen—Oct. 14, 1910. No. 18905 D.

Shops.

Repair Shop Practice of the Portland Railroad Company. Illustrated description of electric railway repair shops at Portland, Maine, and their equipment. 2500 w. Elec Ry Jour—Nov. 26, 1910. No. 18859.

Subways.

The Triborough Subway in New York City; Statement by Chairman Willcox of the Public Service Commission. An account of the present stage of the subway developments. 2000 w. Eng News—Nov. 24, 1910. No. 18877.

A Great Subterranean Railway Junction. Interesting illustration of conditions at 42nd St. and Madison Ave., New York City, showing five distinct lines of railway, with brief notes. 1000 w. Sci Am—Nov. 19, 1910. No. 18644.

Systems.

Economic Considerations Governing the Selection of Electric Railroad Apparatus. F. Darlington. Discusses the relative merits of the three electric railroad systems from the standpoint of economy of construction and operation. Ills. General discussion. 13500 w. Jour W Soc of Engrs—Oct., 1910. No. 18833 D.

We supply copies of these articles. See page 670.

EXPLANATORY NOTE—THE ENGINEERING INDEX

We hold ourselves ready to supply—usually by return of post—the full text of every article indexed in the preceding pages, *in the original language*, together with all accompanying illustrations; and our charge in each case is regulated by the cost of a single copy of the journal in which the article is published. The price of each article is indicated by the letter following the number. When no letter appears, the price of the article is 20 cts. The letter A, B, or C denotes a price of 40 cts.; D, of 60 cts.; E, of 80 cts.; F, of $1.00; G, of $1.20; H, of $1.60. When the letter N is used it indicates that copies are not readily obtainable and that particulars as to price will be supplied on application. Certain journals, however, make large extra charges for back numbers. In such cases we may have to increase proportionately the normal charge given in the Index. In ordering, care should be taken to *give the number* of the article desired, not the title alone.

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THE PUBLICATIONS REGULARLY REVIEWED AND INDEXED

The titles and addresses of the journals regularly reviewed are given here in full, but only abbreviated titles are used in the index. In the list below, *w* indicates a weekly publication, *b-w*, a bi-weekly, *s-w*, a semi-weekly, *m*, a monthly, *b-m*, a bi-monthly, *t-m*, a tri-monthly, *qr*, a quarterly, *s-q*, semi-quarterly, etc. Other abbreviations used in the index are: Ill—Illustrated; W—Words; Anon—Anonymous.

Alliance Industrielle. *m.* Brussels.
American Architect. *w.* New York.
Am. Engineer and R. R. Journal. *m.* New York.
American Jl. of Science. *m.* New Haven, U. S. A.
American Machinist. *w.* New York.
Anales de la Soc. Cien. Argentina. *m.* Buenos Aires.
Annales des Ponts et Chaussées. *m.* Paris.
Ann. d Soc. Ing. d Arch Ital. *s-m.* Rome.
Architect. *w.* London.
Architectural Record. *m.* New York.
Architectural Review. *s-q.* Boston.
Architect's and Builder's Magazine. *m.* New York.
Australian Mining Standard. *w.* Melbourne.
Autocar. *w.* Coventry, England.
Automobile. *w.* New York.
Automotor Journal. *w.* London.
Beton und Eisen. *qr.* Vienna.
Boiler Maker. *m.* New York.
Brass World. *m.* Bridgeport, Conn.
Brickbuilder. *m.* Boston.
Builder. *w.* London.
Bull. Bur. of Standards. *qr.* Washington.
Bulletin de la Société d'Encouragement. *m.* Paris.
Bulletin of Dept. of Labor. *b-m.* Washington.
Bull. of Can. Min. Inst. *qr.* Montreal.
Bull. Soc. Int. d'Electriciens. *m.* Paris.
Bulletin of the Univ. of Wis., Madison, U. S. A.
Bull. Int. Railway Congress. *m.* Brussels.
Bull. Scien. de l'Assn. des Elèves des Ecoles Spéc. *m.* Liége.
Bull. Tech. de la Suisse Romande. *s-m.* Lausanne.
California Jour. of Tech. *m.* Berkeley, Cal.
Canadian Architect. *m.* Toronto.
Canadian Electrical News. *m.* Toronto.
Canadian Engineer. *w.* Toronto and Montreal.
Canadian Mining Journal. *b-w.* Toronto.
Cassier's Magazine. *m.* New York and London.
Castings. *m.* Cleveland, O.
Cement. *m.* New York.
Cement Age. *m.* New York.
Central Station. *m.* New York.
Chem. Met. Soc. of S. Africa. *m.* Johannesburg.
Colliery Guardian. *w.* London.
Commercial Vehicle. *m.* New York.

Compressed Air. *m.* New York.
Cornell Civil Engineer. *m.* Ithaca.
Deutsche Bauzeitung. *b-w.* Berlin.
Die Turbine. *s-m.* Berlin.
Domestic Engineering. *w.* Chicago.
Economic Geology. *m.* New Haven, Conn.
Electrical Age. *m.* New York.
Electrical Engineer. *w.* London.
Electrical Engineering. *w.* London.
Elec. Review and W. Elec'n. *w.* Chicago.
Electrical Review. *w.* London.
Electric Journal. *m.* Pittsburg, Pa.
Electric Railway Journal. *w.* New York.
Electrical World. *w.* New York.
Electrician. *w.* London.
Electricien. *w.* Paris.
Elektrische Kraftbetriebe u Bahnen. *w.* Munich.
Elektrochemische Zeitschrift. *m.* Berlin.
Elektrotechnik u Maschinenbau. *w.* Vienna.
Elektrotechnische Rundschau. *w.* Potsdam.
Elettricità. *w.* Milan.
Engineer. *w.* London.
Engineering. *w.* London.
Engineering-Contracting. *w.* New York.
Engineering Magazine. *m.* New York and London.
Engineering and Mining Journal. *w.* New York.
Engineering News. *w.* New York.
Engineering Record. *w.* New York.
Eng. Soc. of Western Penna. *m.* Pittsburg, U. S. A.
Far Eastern Review. *m.* Manila.
Foundry. *m.* Cleveland, U. S. A.
Génie Civil. *w.* Paris.
Giesserei-Zeitung. *s-m.* Berlin.
Glasers Ann. f Gewerbe & Bauwesen. *s-m.* Berlin.
Heating and Ventilating Mag. *m.* New York.
Horseless Age. *w.* New York.
Ice and Cold Storage. *m.* London.
Ice and Refrigeration. *m.* New York.
Il Cemento. *s-m.* Milan.
Industrial World. *w.* Pittsburg.
Ingegneria Ferroviaria. *s-m.* Rome.
Ingenieur. *w.* Hague.
Insurance Engineering. *m.* New York.
Int. Marine Engineering. *m.* New York.
Iron Age. *w.* New York.
Iron and Coal Trades Review. *w.* London.
Iron Trade Review. *w.* Cleveland, U. S. A.
Jour. of Accountancy. *m.* N. Y.
Journal Am. Soc. of Engineering-Contractors. *m.* New York.
Journal Asso. Eng. Societies. *m.* Philadelphia.
Journal Franklin Institute. *m.* Philadelphia.
Jour. N. E. Water Works Assn. *qr.* Boston.
Journal Royal Inst. of Brit. Arch. *s-q.* London.
Jour. Roy. United Service Inst. *m.* London.
Journal of Sanitary Institute. *qr.* London.
Jour. of South African Assn. of Engineers. *m.* Johannesburg, S. A.
Journal of the Society of Arts. *w.* London.
Jour. Transvaal Inst. of Mech. Engrs., Johannesburg, S. A.
Jour. of U. S. Artillery. *b-m.* Fort Monroe, U. S. A
Jour. W. of Scot. Iron & Steel Inst. *m.* Glasgow.
Journal Western Soc. of Eng. *b-m.* Chicago.
Jour. of Worcester Poly. Inst., Worcester, U. S. A.
Locomotive. *m.* Hartford, U. S. A.
Machinery. *m.* New York.
Manufacturer's Record. *w.* Baltimore.
Marine Review. *w.* Cleveland, U. S. A.
Mechanical Engineer. *w.* London.
Mechanical World. *w.* Manchester.
Mem. de la Soc. des Ing. Civils de France. *m.* Paris.
Metallurgical and Chem. Engng. *m.* New York.
Métallurgie. *w.* Paris.
Metal Worker. *w.* New York.
Mines and Minerals. *m.* Scranton, U. S. A.
Mining and Sci. Press. *w.* San Francisco.
Mining Journal. *w.* London.
Mining Magazine. *m.* London.
Mining World. *w.* Chicago.
Mittheilungen des Vereins für die Förderung des Local- und Strassenbahnwesens. *m.* Vienna.
Municipal Engineering. *m.* Indianapolis, U. S. A.
Municipal Journal and Engineer. *w.* New York.
Nautical Gazette. *w.* New York.
New Zealand Mines Record. *m.* Wellington.
Oest. Wochensch. f. d. Oeff. Baudienst. *w.* Vienna.
Oest. Zeitschr. Berg- & Hüttenwesen. *w.* Vienna.
Power and The Engineer. *w.* New York.
Practical Engineer. *w.* London.
Pro. Am. Ins. Electrical Eng. *m.* New York.
Pro. Am. Ins. of Mining Eng. *m.* New York.
Pro. Am. Soc. Civil Engineers. *m.* New York.
Pro. Am. Soc. Mech. Engineers. *m.* New York.
Pro. Canadian Soc. Civ. Engrs. *m.* Montreal.
Proceedings Engineers' Club. *qr.* Philadelphia.
Pro. Engrs. Soc. of Western Pennsylvania. *m.* Pittsburg.
Pro. St. Louis R'way Club. *m.* St. Louis, U. S. A.
Pro. U. S. Naval Inst. *qr.* Annapolis, Md.
Progressive Age. *s-m.* New York.
Public Works. *qr.* London.
Quarry. *m.* London.
Queensland Gov. Mining Jour. *m.* Brisbane, Australia.
Railway Age Gazette. *m.* New York.
Railway and Engineering Review. *w.* Chicago.
Railway and Loc. Engng. *m.* New York.
Railway Master Mechanic. *m.* Chicago.
Revue d'Electrochimie et d'Electrométallurgie. *m.* Paris.
Revue de Mécanique. *m.* Paris.
Revue de Métallurgie. *m.* Paris.
Revue Gén. des Chemins de Fer. *m.* Paris.
Revue Gén. des Sciences. *w.* Paris.
Revue Industrielle. *w.* Paris.
Rivista Marittima. *m.* Rome.
Rudder. *m.* New York.
Schiffbau. *s-m.* Berlin.
School of Mines Quarterly. *q.* New York.
Schweizerische Bauzeitung. *w.* Zürich.
Scientific American. *w.* New York.
Scientific Am. Supplement. *w.* New York.
Sibley Jour. of Mech. Eng. *m.* Ithaca, N. Y.
Signal Engineer. *m.* Chicago.
Soc. Belge des Elect'ns. *m.* Brussels.
Stahl und Eisen. *w.* Düsseldorf.
Stevens Institute Indicator. *qr.* Hoboken, U. S. A.
Surveyor. *w.* London.
Technique Moderne. *m.* Paris.
Tramway & Railway World. *m.* London.
Trans. Inst. of Engrs. & Shipbuilders in Scotland, Glasgow.
Wood Craft. *m.* Cleveland, U. S. A.
Yale Scientific Monthly. *m.* New Haven.
Zeitschr. f. d. Gesamte Turbinenwesen. *w.* Munich.
Zeitschr. d. Mitteleurop. Motorwagen. Ver. *s-m.* Berlin.
Zeitschr. d. Oest. Ing. u. Arch. Ver. *w.* Vienna.
Zeitschr. d. Ver. Deutscher Ing. *w.* Berlin.
Zeitschr. f. Werkzeugmaschinen. *b-w.* Berlin.

CURRENT RECORD OF NEW BOOKS

NOTE—Our readers may order through us any book here mentioned, remitting the publisher's price as given in each notice. Checks, Drafts, and Post Office Orders, home and foreign, should be made payable to THE ENGINEERING MAGAZINE.

Economic Geology.

Economic Geology, with Special Reference to the United States. By Heinrich Ries. Size, 9 by 6 in.; pp. xxxiii, 589. Ills. Price, $3.50. New York: The Macmillan Company.

A new edition of this standard work required but little introduction. In the four years since it first appeared it has attained a foremost place as a textbook and as a book of reference. Prof. Ries' revision has extended to all parts of the work. Much matter of a general character, dealing with the principles of the subject, has been added, and certain additional individual occurrences have been described. The statistical part also has been brought fully up to date.

Internal-Combustion Engines.

The Construction and Working of Internal-Combustion Engines. By R. E. Mathot. Translated from the French by W. A. Tookey. Size, 9½ by 6 in.; pp., xxii, 554. Ills. Price, $6. New York: D. Van Nostrand Company.

M. Mathot is, to English and American engineers, probably the best known of the Continental specialists in gas-power machinery. His papers before the British and American engineering societies of which he is a member, his frequent contributions to the technical press, and his earlier book on the gas engine and gas producer, which won such flattering recognition from Mr. Dugald Clerk, have served to introduce him to a large number of engineers who will welcome the appearance of his latest work.

The present book was originally published in Paris in 1907. The translator, however, at the author's express request, has fully revised the work to meet the requirements of English and American engineers, and has brought it fully up to date. M. Mathot's treatment is descriptive rather than theoretical. The first section, of three chapters, deals with the progress and future of gas power, and the relative merits of gas and steam engines. Part II, which takes up over 300 pages, discusses construction and design, and enters into full descriptions of the various types of gas engines and of their mechanical details. The third section considers questions of power and efficiency, testing and testing apparatus, indicator diagrams, etc., while a bibliography of the subject and a list of gas-engine and gas-producer makers are given in appendices. The large number of very clear illustrations is a feature of the book, and a full index adds greatly to its convenience as a work of reference.

Iron and Steel.

Iron and Steel—A Pocket Encyclopedia. By Hugh P. Tiemann. Size, 7 by 4 in.; pp., 354. Ills. Price, $3. New York and London: McGraw-Hill Book Company.

Henry M. Howe says in a brief introduction to this comprehensive dictionary of iron and steel metallurgical terms: "The gallant author comes to the aid of the fumbling metallographist and irritated millman. With infinite pains, ingenuity and skill he blesses both where they had banned each other, and enables the brothers to dwell together in harmony, unfolding to each the jargon of the other by means of a tri-lingual dictionary, translating the jargons of both into the common language, English. Nor are they alone his debtors. Having long lived a metallographist and a teacher among the millmen he discloses clearly, tersely, and graphically the manners and customs of the millmen, to wit, the how and the why of their actual practice, as only a resident can know it. In short, he describes the actual metallurgical operations and apparatus in a way which seems to me most admirable." With Dr. Howe's opinion we are heartily in accord, and we have no hesitation in commending Mr. Tiemann's book as an extremely handy compendium of iron and steel works processes, practice, and apparatus.